APPENDIX A-3

(MAIN POINTS OF FEASIBILITY STUDY)

APPENDIX A-3-1

MEMORANDUM

As for the proposed TLP system of the tailings from Baguio Mining Area to Lingayen Gulf, the following are mutually understood between both parties: MR. JUANITOC. FERNANDEZ - Director of the Bureau of Mines of the Republic of the Philippines, and MR. KEN SAITO - Leader of the mission.

1) FEASIBILITY STUDY covers the designing of the above TLP system and some proposals to the final tailing disposal in Lingayen Gulf.

2) The construction and the operation of the system essentially request the participation and cooperation of 6 mines concerned.

3) The TLP system consists of three portions: feeder lines, common line and the final disposal in Lingayen Gulf.

a) TECHNICAL RECOMMENDATION to individual feeder lines shall be made and the tailings charged into the common line shall be under physically acceptable conditions (size distribution, density, volume, etc.).

b) The right of the way shall be given to the common line.

c) More than single plannings for the final tailings disposal in the Gulf will be made.

4) The mining production in the future be based upon the plannings of each mines submitted to the Mission.

5) The designing relies upon Topo-Maps of One is to Fifty Thousand.

6) The designing be carried out under the condition of the lack of the following:

a) detailed topographical survey
b) level survey
c) geophysical survey
d) drillings
e) field test of launder and pipe line

Signed by KENSAITO Leader of Mission	Signed by JUANITOC. FERNANDEZ Director of Mines

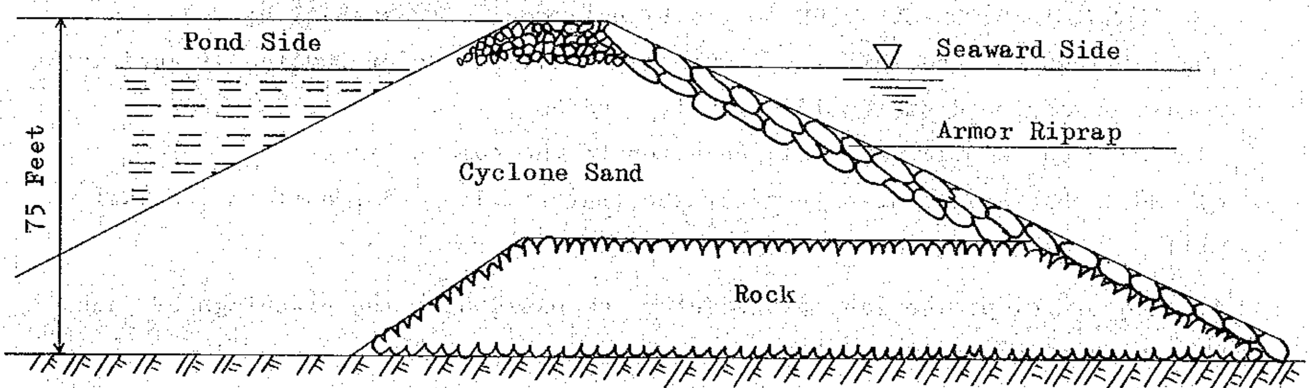
February 16, 1978

APPENDIX A-3-2 EXAMPLES OF TAILINGS DISPOSAL SYSTEM

A-3-2-1 Marcopper Mine

Marcopper Mining Corporation (Marinduque Isl.) embloys ocean dumping system for tailings disposal. At first it was planned to build bulkhead to connect Banot Island and the mainland coast enclosing the Calancan Bay but later they decided to employ the system of dumping the tailings direct into the sea.

The original plan called for building dams 75 feet high, using rubble and classified sand and covering the seaward face with armor riprap.



The original plan

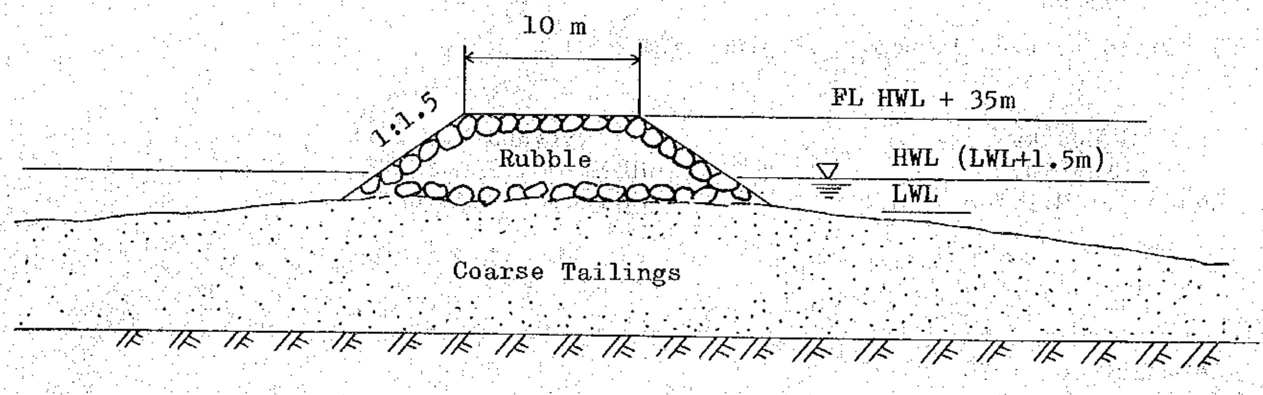
a. Present Condition

i) Amount of tailings 20,000 t/day

ii) Pulp density of slurry: 50~52%(ST%)

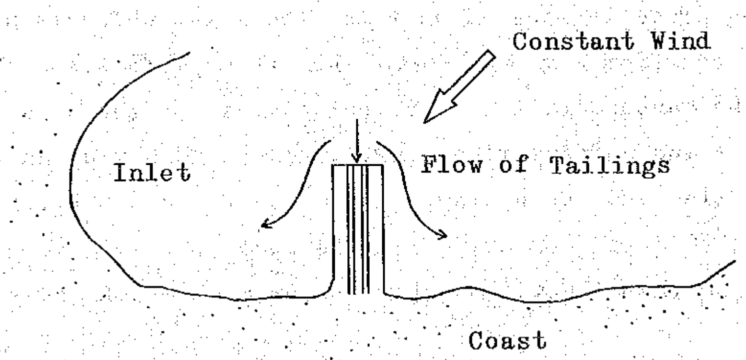
iii) Commencement of ocean dumping: October 1975

iv) Construction of causeway



The causeway for laying the pipelines is carried by a rubble bank that is constructed with tailings. At present the causeway is 2.7 km long. The water depth at its end (tailing outlet) is 13 m and the sea bottom gradient is 20^{o}. Since the causeway is built with the use of coarse-grained tailings, it is normally stabilized but the Feasibility study mission was informed that armor riprap was necessary for foot protection at the time of typhoon.

There is a constant wind blows towards the tailings outlet from the offing and the flow of current is constant as caused by the wind and waves so that the discharged tailings are always carried coastwards. Therefore, the tailings are considered to have deposited on the bottom of the outlet in the widespread area, not extending out into the offing.



<u>Reference</u> Trial computation of earth sediment

Assuming Oct. 1975 - Feb. 1978 = 30 months

$$20{,}000 \text{ t/day} \times 30 \times 30 \times \frac{1}{1.8} = 10{,}000{,}000 (m^3)$$

Causeway is 2,700 m long

Coarse sand is 1/2 of the total, sediment,

$$10{,}000{,}000 \ m^3 \times \frac{1}{2} \times \frac{1}{2{,}700 \ m} = 1{,}852 \ (m^3/m)$$

Assuming the present water depth at the end of causeway to be 40 feet and the average depth to be 7 m,

$$1{,}852 \div 7 \doteqdot 265 \ (m^2/m)$$

Therefore, coarse sand is considered deposited in a width of 250 to 300 m with the tailings outlet as the center.

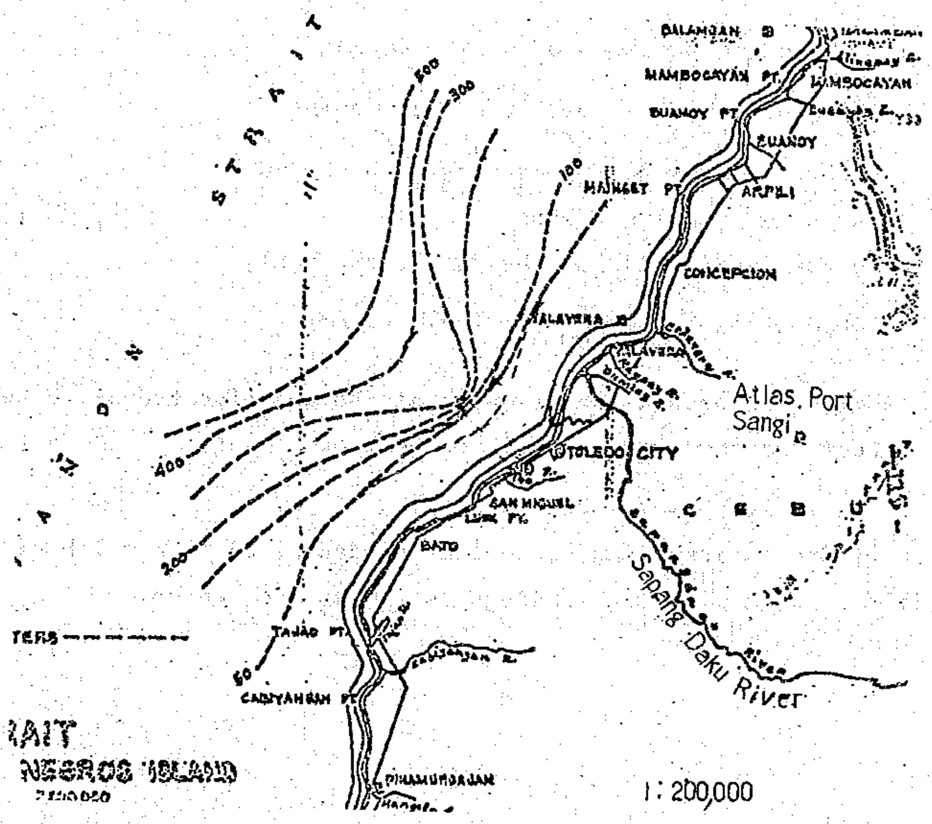
A-3-2-2 Atlas Mine

Atlas Mine employs a system in which the tailings are dumped into the sea near the Ibo Point facing the Tanõn Strait.

For dumping the tailings, the company chose a place where a trench in the floor of the Tanõn Strait cuts deep in the direction of the Cebu Island so that the dumped tailings are carried away into a deep trough in the offing by the strong current arising in the vicinity of the dumping place.

a. Oceanographic and topographic conditions in the vicinity of the dumping place

The dumping place is located near the Ibo Point which is south of Toledo City. As seen from Fig. A-3-2-1, this is a place where the trench in the floor of the Tanõn Strait is stretching close to the coast. In the Tanõn Strait the current flows northwards at high tide and flows southwards at low tide and the average flow velocity is 3.9 kt. The water depth is 50 m at 1 km away from the coast, where the sea bottom inclines steeply and that the water depth is 350 m at 1.5 km away from the coast.

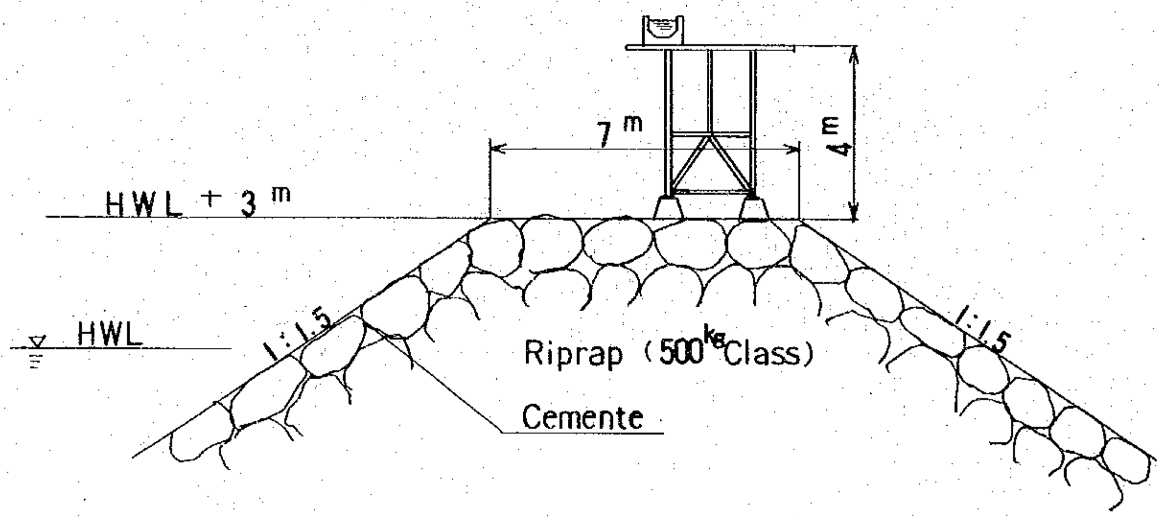


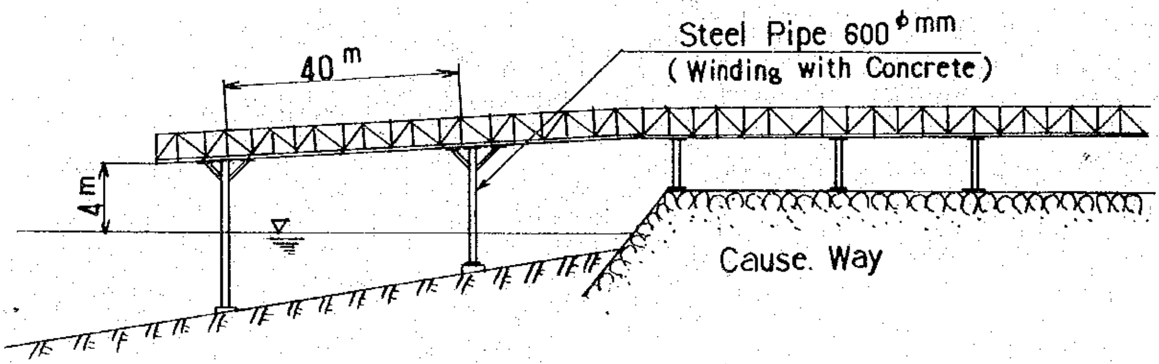
b. Dumping condition

At present the water depth immediately beneath the tailings outlet is 12 m. The sediment of deposited tailings under the outlet remains in the stable state at an angle of repose of 20°. If this angle is exceeded, the tailings will be carried away by submarine current into the offing. Investigations are made on the tailings deposition every three months and environmental investigations are made ten times a year.

c. Construction of tailings outlet

Causeway (490 m in length)





APPENDIX A-4

(CONDITIONS OF LOCATION OF TLPS)

APPENDIX A-4-3 RECORDS OF CYCLONES, TYPHOONS, STORMS, TIDE, ETC.

A-4-3-1 (1) Monthly and annual frequencies of tropical cyclones in the Philippine area of responsibility: cy 1948 - 76

Calendar Year	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1948	21	1	0	0	0	2	0	3	1	3	2	6	3
1949	22	1	0	0	0	0	3	4	2	4	3	4	1
1950	13	0	0	0	0	0	2	3	1	3	2	1	1
1951	13	0	0	0	0	1	1	1	3	2	1	2	1
1952	29	0	0	0	0	1	5	2	4	4	5	3	5
1953	18	0	1	0	0	1	2	0	5	2	2	4	1
1954	18	0	0	1	0	1	0	1	6	2	3	3	1
1955	15	1	1	0	1	0	0	2	3	1	4	1	1
1956	28	0	0	1	2	0	0	5	4	5	3	5	3
1957	15	2	0	0	1	0	2	1	2	3	3	1	0
1958	18	1	0	0	0	0	1	4	3	3	2	4	0
1959	18	0	1	1	0	0	0	1	4	2	4	3	2
1960	19	1	0	0	1	1	2	2	6	1	3	0	2
1961	23	1	1	1	0	1	3	4	4	4	1	1	2
1962	22	0	1	0	0	2	0	5	6	4	1	3	0
1963	16	0	0	0	0	0	4	4	2	3	1	0	2
1964	32	0	0	0	0	3	1	8	6	5	4	3	2
1965	21	2	1	1	0	1	3	4	4	3	1	1	0
1966	22	0	0	0	1	3	1	7	1	3	1	3	2
1967	21	0	1	1	1	1	2	4	5	0	2	3	1
1968	16	0	0	1	0	0	1	3	3	3	2	3	0
1969	15	0	0	0	1	1	0	4	2	3	2	2	0
1970	21	0	1	0	0	0	1	3	4	5	3	3	1
1971	27	1	0	1	2	4	2	5	2	4	4	2	0
1972	17	2	0	0	0	0	2	4	2	4	1	1	1
1973	12	0	0	0	0	0	1	2	3	2	3	1	0
1974	23	1	0	0	0	0	2	5	4	2	4	3	2
1975	12	1	0	0	0	0	0	0	3	3	1	3	1
1976	13	1	1	0	1	2	3	2	3	n.a.	n.a.	n.a.	n.a.

a.a. Data not available.

Tropical Cyclones are classified according to the maximum wind speed about their centers. They may fall under any of the following categories:

a) Tropical Depression - up to 61 km/hr
b) Tropical Storm - from 63 to 87 km/hr
c) Severe Tropical Storm - from 88 to 117 km/hr
d) Typhoon - above 118 km/hr

Source of data: Climatological Division, Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). "Tropical Cyclones for 1972" published April 1973.

A-4-3-1 (2) Monthly and annual frequencies of typhoons in the Philippine area of responsibility: cy 1948 - 76

Calendar Year	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1948	14	1	0	0	0	2	0	2	1	3	12	2	2
1949	10	1	0	0	0	0	1	1	0	2	2	2	1
1950	6	0	0	0	0	0	1	1	0	1	1	1	1
1951	8	0	0	0	0	1	0	1	1	1	0	2	2
1952	16	0	0	0	0	0	2	2	3	0	4	3	2
1953	10	0	1	0	0	1	1	0	3	2	1	1	0
1954	11	0	0	0	0	1	0	1	2	2	2	3	0
1955	8	0	0	0	1	0	0	1	2	1	2	0	1
1956	17	0	0	1	1	0	0	1	3	4	2	4	1
1957	10	1	0	0	1	0	1	1	1	3	1	1	0
1958	13	1	0	0	0	0	1	4	2	2	2	1	0
1959	12	0	0	0	0	0	0	1	3	1	3	2	2
1960	12	0	0	0	1	0	1	2	3	0	3	0	2
1961	10	0	0	1	0	1	0	2	2	3	0	0	1
1962	15	0	0	0	0	2	0	3	4	2	1	3	0
1963	9	0	0	0	0	0	3	2	1	2	1	0	0
1964	16	0	0	0	0	1	1	4	2	4	2	1	1
1965	12	1	0	0	0	1	2	2	3	2	0	1	0
1966	10	0	0	0	1	2	1	2	1	2	0	0	1
1967	11	0	0	1	1	0	1	2	1	0	2	3	0
1968	11	0	0	0	0	0	1	1	1	3	2	3	0
1969	9	0	0	0	1	0	0	2	2	1	2	1	0
1970	8	0	1	0	0	0	0	1	2	1	2	1	0
1971	15	1	0	0	1	1	2	4	1	3	1	1	0
1972	7	1	0	0	0	0	1	1	1	1	0	1	1
1973	5	0	0	0	0	0	0	1	1	0	3	0	0
1974	9	0	0	0	0	0	1	2	0	0	4	2	0
1975	6	0	0	0	0	0	0	0	3	2	0	1	0
1976	6	0	0	0	1	2	1	0	1	1	n.a.	n.a.	n.a.

n.a. Data not available.

Typhoons - maximum wind speed within the disturbance exceeds 118 km/hr. (64 knots) or 74 mph.

Source of data: Climatological Divisiom, Philippine Atmosperic, Geophysical and Astronomical Services Administration (PAGASA).
"Tropical Cyclones for 1972" published April 1973.

A-4-3-1 (3) Monthly and annual frequencies of tropical storms in the Philippine area of responsibility: cy 1948 - 76

Calendar Year	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1948	0	0	0	0	0	0	0	0	0	0	0	0	0
1949	6	0	0	0	0	0	1	2	0	1	1	1	0
1950	1	0	0	0	0	0	0	0	0	1	0	0	0
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	6	0	0	0	0	0	1	0	1	2	0	0	2
1953	5	0	0	0	0	0	1	0	2	0	0	2	0
1954	4	0	0	1	0	0	0	0	2	0	0	0	1
1955	4	1	1	0	0	0	0	0	1	0	1	0	0
1956	3	0	0	0	1	0	0	1	1	0	0	0	0
1957	3	1	0	0	0	0	0	0	0	0	2	0	0
1958	1	0	0	0	0	0	0	0	1	1	1	0	0
1959	5	0	1	1	0	0	0	0	1	1	1	0	0
1960	5	0	0	0	0	1	1	0	2	1	0	0	0
1961	7	1	1	0	0	0	1	1	0	1	1	1	0
1962	3	0	1	0	0	0	0	1	1	0	0	0	0
1963	5	0	0	0	0	0	1	1	0	1	0	0	2
1964	9	0	0	0	0	1	0	1	2	1	2	2	0
1965	5	0	1	1	0	0	1	1	0	1	0	0	0
1966	5	0	0	0	0	0	0	2	0	1	0	2	0
1967	7	0	1	0	0	1	0	2	2	0	0	0	1
1968	5	0	0	1	0	0	0	2	2	0	0	0	0
1969	3	0	0	0	0	0	0	1	0	1	0	1	0
1970	7	0	0	0	0	0	0	2	1	2	1	1	0
1971	9	0	0	1	1	2	0	0	1	1	3	0	0
1972	1	0	0	0	0	0	0	0	0	1	0	0	0
1973	5	0	0	0	0	0	1	0	1	2	0	1	0
1974	11	1	0	0	0	0	1	2	3	2	0	1	1
1975	3	1	0	0	0	0	0	0	0	0	1	1	0
1976	3	0	0	0	0	0	1	0	2	n.a.	n.a.	n.a.	n.a.

n.a. Data not available.

Tropical Storm - maximum wind speed within the disturbance ranges from 63-87 kilometers per hour.

Source of data: Climatological Division, Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). "Tropical Cyclones for 1972" published April 1973.

A-4-3-1 (4) Monthly and annual frequencies of tropical depressions in the Philippine area of responsibility: cy 1948 - 76

Calendar Year	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1948	7	0	0	0	0	0	0	1	0	0	1	4	1
1949	6	0	0	0	0	0	1	1	2	1	0	1	0
1950	6	0	0	0	0	0	1	2	1	1	1	0	0
1951	5	0	0	0	0	0	1	0	2	1	1	0	0
1952	7	0	0	0	0	1	2	0	0	2	1	0	1
1953	3	0	0	0	0	0	0	0	0	0	1	1	1
1954	3	0	0	0	0	0	0	0	2	0	1	0	0
1955	3	0	0	0	0	0	0	1	0	0	1	1	0
1956	8	0	0	0	0	0	0	3	0	1	1	1	2
1957	2	0	0	0	0	0	1	0	1	0	0	0	0
1958	4	0	0	0	0	0	0	0	0	1	0	3	0
1959	1	0	0	0	0	0	0	0	0	0	0	1	0
1960	2	1	0	0	0	0	0	0	1	0	0	0	0
1961	6	0	0	0	0	0	2	1	2	0	0	0	1
1962	4	0	0	0	0	0	0	1	1	2	0	0	0
1963	2	0	0	0	0	0	0	1	1	0	0	0	0
1964	7	0	0	0	0	1	0	3	2	0	0	0	1
1965	4	1	0	0	0	0	0	1	1	0	1	0	0
1966	7	0	0	0	0	1	0	3	0	0	1	1	1
1967	3	0	0	0	0	0	1	0	2	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	3	0	0	0	0	1	0	1	0	1	0	0	0
1970	6	0	0	0	0	0	1	0	1	2	0	1	1
1971	3	0	0	0	0	1	0	1	0	0	0	1	0
1972	9	1	0	0	0	0	1	3	1	2	1	0	0
1973	2	0	0	0	0	0	1	1	0	0	0	0	0
1974	3	0	0	0	0	0	0	1	1	0	0	0	1
1975	3	0	0	0	0	0	0	0	0	1	0	1	1
1976	5	1	1	0	0	0	1	2	0	n.a.	n.a.	n.a.	n.a.

Tropical depressions - maximum wind speed within the disturbance up to 61 kilometers per hour.

Source of data: Climatological Division Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA). "Tropical Cyclones for 1972" published April 1973.

A-4-3-2 (1) Times and Heights of High and Low Waters, 1977

San Fernando Harbor, Philippines

Times and Heights of High and Low Waters

1977

January						February						March					
DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.
1	0649	0.02	16	0330	-0.13	1	0439	-0.13	16	0421	-0.21	1	0304	-0.10	16	0249	-0.14
SA	1829	0.55	SU	1819	0.68	TU	1858	0.61	W	1934	0.66	TU	1735	0.53	W	1820	0.57
2	0530	-0.05	17	0412	-0.21	2	0457	-0.15	17	0453	-0.18	2	0326	-0.11	17	0318	-0.10
SU	1856	0.60	M	1903	0.73		1938	0.64	TH	2020	0.62	W	1825	0.57	TH		
3	0524	-0.09	18	0453	-0.25	3	0519	-0.16	18	0520	-0.14	3	0350	-0.11	18	0339	-0.04
M	1926	0.65	TU	1948	0.75	TH	2019	0.65	F	2104	0.56	TH	1914	0.58	F	1000	0.15
																1211	0.14
																2007	0.47
4	0538	-0.13	19	0534	-0.26	4	0541	-0.16	19	0540	-0.08	4	0411	-0.10	19	0351	0.04
TU	2000	0.68	W	2031	0.75	F	2059	0.64	SA	2143	0.49	F	2002	0.57	SA	0939	0.20
																1356	0.13
																2055	0.40
5	0559	-0.15	20	0612	-0.24	5	0602	-0.14	20	0549	-0.03	5	0429	-0.07	20	0356	0.09
W	2034	0.70	TH	2113	0.71	SA	2140	0.60	SU	1137	0.13	SA	1007	0.09	SU	0944	0.26
										1444	0.11		1229	0.08		1515	0.12
										2219	0.41		2048	0.53		2139	0.33
6	0625	-0.17	21	0646	-0.20	6	0620	-0.11	21	0551	0.05	6	0443	-0.03	21	0351	0.13
TH	2111	0.71	F	2153	0.65	SU	2221	0.54	M	1145	0.20	SU	1004	0.14		1000	0.32
										1614	0.13		1410	0.08		1628	0.11
										2250	0.32		2136	0.44		2221	0.26
7	0653	-0.18	22	0.712	-0.15	7	0634	-0.06	22	0544	0.08	7	0452	0.05	22	0340	0.15
F	2149	0.70	SA	2229	0.57	M	1236	0.12	TU	1206	0.26	M	1024	0.22	TU	1021	0.38
							1518	0.11		1748	0.15		1540	0.08		1738	0.10
							2303	0.44		2314	0.20		2226	0.38		2304	0.20
8	0719	-0.17	23	0729	-0.09	8	0643	-0.02	23	0530	0.09	8	0456	0.09	23	0320	0.15
SA	2226	0.64	SU	2300	0.47	TU	1257	0.20	W	1237	0.31	TU	1052	0.31	W	1046	0.42
							1721	0.14		1948	0.15		1713	0.07		1853	0.08
							2347	0.33		2323	0.17		2320	0.27		2359	0.15
9	0743	-0.15	24	0735	-0.04	9	0646	0.05	24	0506	0.09	9	0450	0.12	24	0244	0.13
SU	2306	0.60	M	2323	0.37	W	1332	0.30	TH	1314	0.36	W	1130	0.39	TH	1116	0.46
							1945	0.14					1854	0.05		2020	0.07
10	0804	-0.11	25	0732	0.03	10	0033	0.21	25	0431	0.07	10	0026	0.17	25	1151	0.49
M	2345	0.50	TU	2324	0.28	TH	0637	0.06	F	1359	0.40	TH	0431	0.12	F	2200	0.04
							1417	0.39					1215	0.47			
							2256	0.08					2055	-0.02			
11	0820	-0.07	26	0718	0.05	11	0136	0.09	26	0326	0.04	11	1307	0.54	26	1234	0.50
TU			W	1529	0.30	F	0606	0.05	SA	1449	0.44	F	2259	-0.07	SA	2326	-0.02
							1508	0.48									
12	0025	0.39	27	0658	0.05	12	0122	-0.05	27	0241	-0.03	12	1404	0.58	27	1325	0.52
W	0827	-0.02	TH	1554	0.36	SA	1601	0.56	SU	1544	0.48	SA			SU		
	1607	0.30															
	2122	0.23															
13	0101	0.26	28	0626	0.04	13	0217	-0.13	28	0247	-0.07	13	0027	-0.13	28	0019	-0.04
TM	0826	0.04	F	1626	0.42	SU	1656	0.61	M	1641	0.51	SU	1509	0.60	M	1427	0.53
	1625	0.40															
14	0807	0.05	29	0537	-0.02	14	0302	-0.19				14	0126	-0.16	29	0100	-0.06
F	1657	0.51	SA	1702	0.47	M	1751	0.65				M	1615	0.61	TU	1533	0.54
15	0255	-0.03	30	0442	-0.06	13	0343	-0.21				15	0213	-0.16	30	0134	-0.07
SA	1737	0.60	SU	1740	0.52	TU		0.67				TU	1720	0.60	W	1641	0.53
			31	0429	-0.10										31	0202	-0.04
			M	1819	0.57										TH	1745	0.53

A-4-3-2 (2) San Fernanto Harbor, Philippines
Times and Heights of High and Low Waters
1977

		April						May						June			
DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.
1	0226	-0.03	16	0155	0.12	1	0104	0.15	16	0732	0.42	1	0739	0.85	16	0812	0.44
F	1046	0.51	SA	0426	0.35	SU	0349	0.43	M	1445	0.14	W	1719	-0.04	TM	1813	0.48
				1416	0.20		1469	0.29									
				1933	0.30		1936	0.34									
2	0244	0.04	17	0152	0.16	2	0184	0.19	17	0613	0.48	2	0837	0.44	17	0346	0.04
SA	0844	0.21	SU	0634	0.42	M	0759	0.83	TU	1728	0.19	TH	1815	-0.26	F	1824	0.06
	1248	0.16		1529	0.13		1227	0.11									
	1945	0.46		2052	0.87		2100	0.14									
3	0255	0.09	18	0141	0.10	3	0051	0.21	18	0837	0.72	3	0918	0.46	18	0912	0.88
SU	0344	0.29	M	0849	0.40	TU	0826	0.03	W	1806	0.07	F	1908	-0.12	SA	1907	0.05
	1414	0.12		1634	0.11		1441	0.03									
	2045	0.39		2257	0.21												
4	0301	0.13	19	0118	0.19	4	0858	0.72	19	0902	0.75	4	1008	0.96	19	0944	0.88
M	0902	0.37	TU	0911	0.53	W	1749	-0.06	TH	1844	0.04	SA	2008	-0.11	SU	1936	0.05
	1537	0.08		1731	0.88												
	2149	0.31		2344	0.17												
5	0256	0.17	20	0009	8.17	5	0934	0.79	20	0930	0.77	5	1042	0.93	20	1019	0.07
TU	0929	0.47	W	0933	0.58	TH	1858	-0.11	F	1922	0.03	SU	2047	-0.08	M	2007	0.06
	1657	0.03		1826	0.06												
	2303	0.23															
6	0240	0.18	21	1000	0.61	6	1017	0.83	21	1001	0.78	6	1126	0.87	21	1057	0.84
W	1004	0.54	TH	1921	0.04	F	2006	-0.14	SA	2002	-0.02	M	2126	-0.03	TU	2035	0.08
	1820	-0.05															
7	1043	0.63	22	1029	0.63	7	1100	0.34	22	1036	0.73	7	1206	0.77	22	1135	0.79
TH	1946	-0.08	F	2017	0.02	SA	2109	-0.14	SU	2042	-0.02	TU	2154	0.07	W	2059	0.11
8	1129	0.67	23	1103	0.64	8	1148	0.31	23	1114	0.77	8	1244	0.67	23	1216	0.71
F	2115	-0.11	SA	2115	-0.03	SU	2205	-0.12	M	2122	-0.02	M	2210	0.13	TH	2119	0.15
9	1219	0.69	24	1142	0.64	9	1237	0.75	24	1156	0.74	9	1311	0.55	24	1257	0.60
SA	2235	-0.13	SU	2208	-0.04	M	2250	-0.08	TU	2158	0.02	TH	2214	0.19	F	2132	0.20
10	1315	0.68	25	1230	0.64	10	1325	0.67	25	1243	0.69	10	0700	0.45	25	0542	0.52
SU	2340	-0.13	M	2257	-0.04	TU	2326	-0.02	M	2228	0.05	F	2207	0.23	SA	1031	0.47
																1341	0.48
																2134	0.34
11	1429	0.65	26	1325	0.62	11	1426	0.58	26	1336	0.62	11	0629	0.54	26	0534	
M			TU	2337	-0.04	W	2347	0.07	TH	2253	0.09	SA	2144	0.24	SU	2135	0.26
12	0030	-0.11	27	1428	0.59	12	1529	0.43	27	1440	0.53	12	0634	0.64	27	0554	0.72
TU	1526	0.60	W			TH	2356	0.13	F	2309	0.14	SU	2054	0.23	M	1509	0.23
13	0107	-0.07	28	0011	-0.02	13	0743	0.41	28	0656	0.44	13	0654	0.71	28	0625	0.03
W	1638	0.54	TH	1541	0.54	F	1246	0.35	SA	1159	0.39	M	1717	0.18	TU	1554	0.12
							1643	0.38		1605	0.43						
							2335	0.18		2316	0.19						
14	0112	-0.02	29	0036	0.05	14	0728	0.48	29	0646	0.55	14	0717	0.76	29	0701	0.92
TH	1747	0.07	F	1659	0.049	SA	1441	0.28	SU	1400	0.28	TU	1728	0.14	W	1641	0.83
							1912	0.20		1756	0.33						
							2344	0.21		2311	0.23						
15	0148	0.07	30	0053	0.10	15	0735	0.56	30	0700	0.65	15	0743	0.81	30	0741	0.99
F	0837	0.29	SA	0748	0.35	SU	1553	0.20	M	1518	0.17	W	1749	0.30	TM	2727	-0.04
	1237	0.24		1229	0.27		1949	0.23		2016	0.24						
	1851	0.40			0.42		2317	0.21		2239	0.23						
									31	0726	0.76						
									TU	1621	0.07						

A-4-3-2 (3) San Fernando Harbor, Philippines
Time and Heights of High and Low Waters
1977

July						August						September					
DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.
1	0823	1.02	16	0821	0.91	1	0940	0.92	16	0922	0.94	1	0436	0.37	16	0500	0.29
F	1813	-0.06	SA	1811	0.11	M	1846	0.16	TU	1748	0.23	TH	1055	0.54	F	1103	0.49
										2337	0.36		1709	0.37		1612	0.36
													2328	0.56		2257	0.66
2	0906	1.03	17	0856	0.92	2	1019	0.83	17	0138	0.35	2	0605	0.37	17	0633	0.26
SA	1057	0.05	SU	1833	0.12	TU	1903	0.22	W	1003	0.78	R	2131	0.47	SA	1212	0.40
							1801	0.26		1648	0.38		1554	0.34		1554	0.36
							2345	0.42								2340	0.73
3	0949	0.99	18	0932	0.91	3	1054	0.73	18	0323	0.38	3	0001	0.61	18	0819	0.23
SU	1936	0.02	M	1856	0.13	W	1908	0.28	TH	1045	0.70	54	0756	0.36	SU		
										1809	0.30		1202	0.39			
													1611	0.36			
4	1029	0.93	19	1908	0.58	4	0150	0.43	19	0012	0.49	4	0039	0.66	19	0029	0.73
M	2009	0.07	TU	1917	0.15	TH	0357	0.43	F	0507	0.39	SU	1454	0.33	M	1010	0.18
							1126	0.62		1128	0.60						
							1903	0.32		1812	0.33						
5	1107	0.84	29	1046	0.82	5	0159	0.51	20	0049	0.58	5	0122	0.69	20	0125	0.82
TU	2030	0.14	W	19334	0.19	F	0633	0.46	SA	0711	0.39	M	1332	0.28	TU	1142	0.13
							1140	0.52		1218	0.49						
							1814	0.34		1805	0.35						
6	1141	0.73	21	1124	0.74	6	0230	0.58	21	0134	0.66	6	0214	0.71	21	0227	0.84
W	2041	0.20	TH	1948	0.23	SA	1816	0.34	SU	0949	0.35	TU	1352	0.24	W	1247	0.10
										1328	0.37						
										1735	0.34						
7	1204	0.62	22	1204	0.64	7	0308	0.64	22	0226	0.75	7	0312	0.73	22	0336	0.83
TH	2040	0.25	F	1956	0.27	SU	1728	0.31	M	1225	0.27	W	1416	0.22	TH	1335	0.09
8	0544	0.51	23	0322	0.54	8	0351	0.70	23	0322	0.82	8	0411	0.75	23	0443	0.91
F	0809	0.51	SA	0819	0.47	M	1624	0.27	TU	1339	0.18	TH	1440	0.20	F	1414	0.11
	1137	0.52		1240	0.52												
	2027	0.28		1956	0.30												
9	0503	0.58	24	0347	0.63	9	0436	0.75	24	0421	0.87	9	0509	0.76	24	0549	0.78
SA	2000	0.29	SU	1939	0.31	TU	1603	0.24	M	1428	0.13	F	1501	0.19	SA	1444	0.15
10	0517	0.66	25	0424	0.74	10	0519	0.79	25	0520	0.91	10	0602	0.78	25	0650	0.73
SU	1910	0.27	M	1437	0.27	W	1608	0.21	TH	1511	0.10	SA	1520	0.19	SU	1506	0.20
																2125	0.38
11	0542	0.73	26	0506	0.83	11	0602	0.82	26	0616	0.92	11	0651	0.78	26	0022	0.34
M	1740	0.23	TU	1506	0.17	TH	1622	0.19	F	1550	0.10	SU	1539	0.21	M	0748	0.66
																1519	0.26
																2111	0.44
12	0612	0.78	27	0552	0.92	12	0643	0.85	27	0710	0.91	12	0741	0.76	27	0203	0.34
TU	1709	0.19	W	1547	0.10	F	1639	0.18	SA	1624	0.13	M	1554	0.24	TU	0842	0.59
													2134	0.37		1522	0.31
																2119	0.51
13	0643	0.83	28	0639	0.97	13	0722	0.87	28	0800	0.33	13	0039	0.35	28	0325	0.31
M	1716	0.16	TH	1629	0.05	SA	1657	0.27	SU	1650	0.13	TU	0327	0.72	W	0934	0.51
													1607	0.27		1516	0.33
													2136	0.42		2136	0.57
14	0715	0.86	29	0726	1.01	14	0802	0.38	29			14	0211	0.33	29	0438	0.28
TH	1731	0.14	F	1710	0.06	SU	1716	0.18	M	1709	0.23	W	0914	0.67	TH	1029	0.43
										2253	0.37		1614	0.31		1459	0.36
													2154	0.50		2158	0.63
15	0748	0.29	30	0813	1.01	15	0341	0.87	30	0131	0.35	15	0336	0.32	30	0548	0.26
F	1749	0.12	SA	1747	0.06	M	1734	0.20	TU	0933	0.74	TH	1007	0.59	F	1134	0.36
										1719	0.29		1618	0.34		1423	0.35
										2249	0.43		2222	0.58		2225	0.67
			31	0856	0.95				31	0308	0.34						
			SU	1820	0.10				W	1015	0.65						

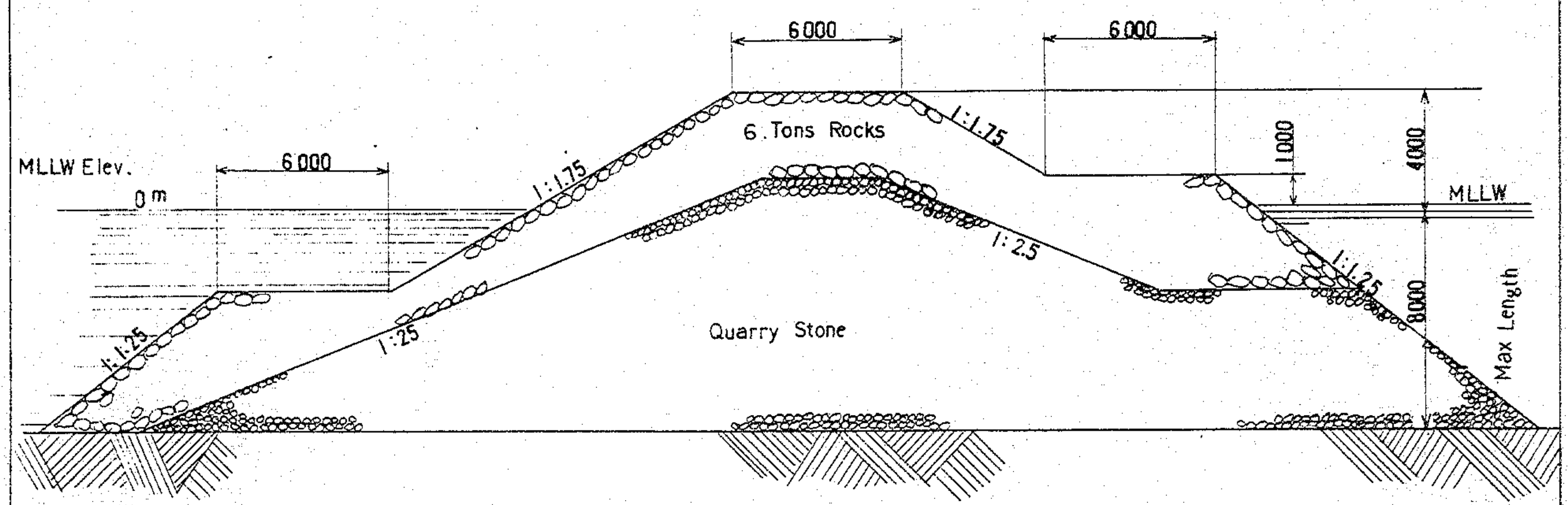
A-4-3-2 (4) San Fernando Harbor, Philippines
Time and Heights of High and Low Waters

1977

October						November						December					
DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.
1	0701	0.23	16	0722	0.07	1	0904	0.06	16	0936	-0.13	1	0902	-0.08	16	0927	-0.11
SA	2255	0.70	SU	2302	0.84	TU	2321	0.73	W			TH	2333	0.67	F		
2	0820	0.22	17	0844	0.03	2	0950	0.05	17	0013	0.78	2	0932	-0.07	17	0029	0.55
SU	2328	0.71	M	2349	0.85	W			TH	1021	-0.10	F			SA	0943	-0.04
3	0944	0.20	18	0958	-0.02	3	0002	0.71	18	0103	0.70	3	0012	0.61	18	0058	0.43
M			TU			TH	1032	0.05	F	1055	-0.04	SA	0958	-0.05	SU	0949	0.04
																1823	0.34
4	0008	0.72	19	0043	0.84	4	0050	0.67	19	0155	0.59	4	0054	0.54	19	0939	0.08
TU	1037	0.18	W	1103	-0.02	F	1107	0.05	SA	1116	0.05	SU	1019	-0.02	M	1759	0.42
5	0053	0.71	20	0142	0.79	5	0145	0.63	20	0251	0.47	5	0148	0.45	20	0915	0.09
W	1151	0.16	TH	1154	0.03	SA	1137	0.07	SU	1127	0.10	M	1035	0.05	TU	1812	0.50
										1921	0.40		1841	0.38			
													2347	0.32			
6	0149	0.71	21	0247	0.73	6	0251	0.57	21	0033	0.34	6	0255	0.33	21	0800	0.07
TH	1230	0.15	F	1232	0.06	SU	1159	0.10	M	0401	0.36	TU	1041	0.09	W	1834	0.57
										1126	0.15		1827	0.46			
										1905	0.47						
7	0254	0.69	22	0357	0.66	7	0408	0.50	22	0244	0.24	7	0206	0.21	22	0502	-0.02
F	1303	0.15	SA	1258	0.12	M	1216	0.14	TU	0540	0.26	W	0453	0.22	TH	1901	0.62
							1934	0.41		1111	0.17		1035	0.12			
										1915	0.55		1840	0.55			
8	0403	0.68	23	0510	0.57	8	0027	0.34	23	0356	0.15	8	0316	0.09	23	0519	-0.07
SA	1329	0.16	SU	1315	0.17	TU	0533	0.42	W	0749	0.18	TH	0732	0.13	F	1931	0.65
				2014	0.42		1225	0.18		1032	0.17		1004	0.12			
							1926	0.49		1935	0.62		1907	0.65			
9	0510	0.66	24	0033	0.36	9	0207	0.25	24	0446	0.08	9	0412	-0.05	24	0542	-0.11
SU	1350	0.18	M	0623	0.49	W	0701	0.34	TH	1959	0.67	F	1939	0.75	SA	2000	0.68
				1321	0.23		1225	0.21									
				2004	0.48		1941	0.58									
10	0615	0.62	25	0217	0.30	10	0323	0.15	25	0530	0.03	10	0506	-0.14	25	0608	-0.13
M	1404	0.21	TU	0735	0.41	TH	0838	0.27	F	2024	0.70	SA	2017	0.81	SU	2030	0.69
	2024	0.41		1317	0.26		1211	0.23									
				2014	0.55		2006	0.67									
11	0041	0.35	26	0334	0.23	11	0431	0.06	26	0608	-0.04	11	0558	-0.20	26	0633	-0.14
TU	0717	0.57	W	0849	0.34	F	2037	0.76	SA	2051	0.72	SU	2058	0.86	M	2059	0.69
	1416	0.25		1301	0.28												
	2024	0.48		2031	0.62												
12	0213	0.29	27	0439	0.18	12	0537	-0.05	27	0644	-0.06	12	0649	-0.24	27	0658	-0.15
W	0820	0.51	TH	1022	0.28	SA	2115	0.83	SU	2119	0.73	M	2141	0.86	TU	2132	0.69
	1420	0.29		1220	0.27												
	2041	0.56		2054	0.67												
13	0332	0.23	28	0537	0.13	13	0640	-0.10	28	0719	-0.08	13	0738	-0.24	28	0722	-0.15
TH	0927	0.43	F	2119	0.71	SU	2156	0.87	M	2149	0.73	TU	2224	0.83	W	2204	0.67
	1417	0.31															
	2106	0.65															
14	0448	0.17	29	0630	0.10	14	0742	-0.14	29	0755	-0.08	14	0823	-0.21	29	0748	-0.14
F	1046	0.35	SA	2144	0.73	M	2239	0.87	TU	2221	0.72	W	2307	0.76	TH	2238	0.64
	1400	0.32															
	2140	0.73															
15	0604	0.12	30	0724	0.08	15	0841	-0.15	30	0828	-0.09	15	0901	-0.17	30	0810	-0.12
SA	2218	0.79	SU	2214	0.74	TU	2324	0.84	W	2255	0.70	TH	2349	0.67	F	2313	0.59
			31	0814	0.07										31	0831	-0.10
			M	2246	0.74										SA	2349	0.51

TIME MERIDIAM 120 DEC. EAST. 0000 IS MIDNIGHT. 1200 IS MOON.
HEIGHTS ARE IN METERS AND RECROMED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

Fig A-4-3-3 Pire Section of SAN FERNAND Port



Proposed Rock Breakwater

Scale 1:200

APPENDIX A-7

(COMMON LINE PLAN)

APPENDIX A-7-1 DATA FOR SELECTION OF SLURRY TRANSPORTATION SYSTEM ON THE COASTAL HEIGHT

Comparison of Combined Launder, Pump and Pipeline System (Case-1) and Pipeline System (Case-2)

Fig.A-7-1 shows a longitudinal section of the launder line or pipeline from the point N at the coastal mountain range to the coast. The site of the pumping station in Case-1 is assumed to be 500 m from the coast to the mountain side and the amount of slurry to be transported is assumed to be 0.78 m^3/s (PD 39% solid) mean and 1.05 m^3/s (PD 35% solid) maximum from Table 5-3 in this report.

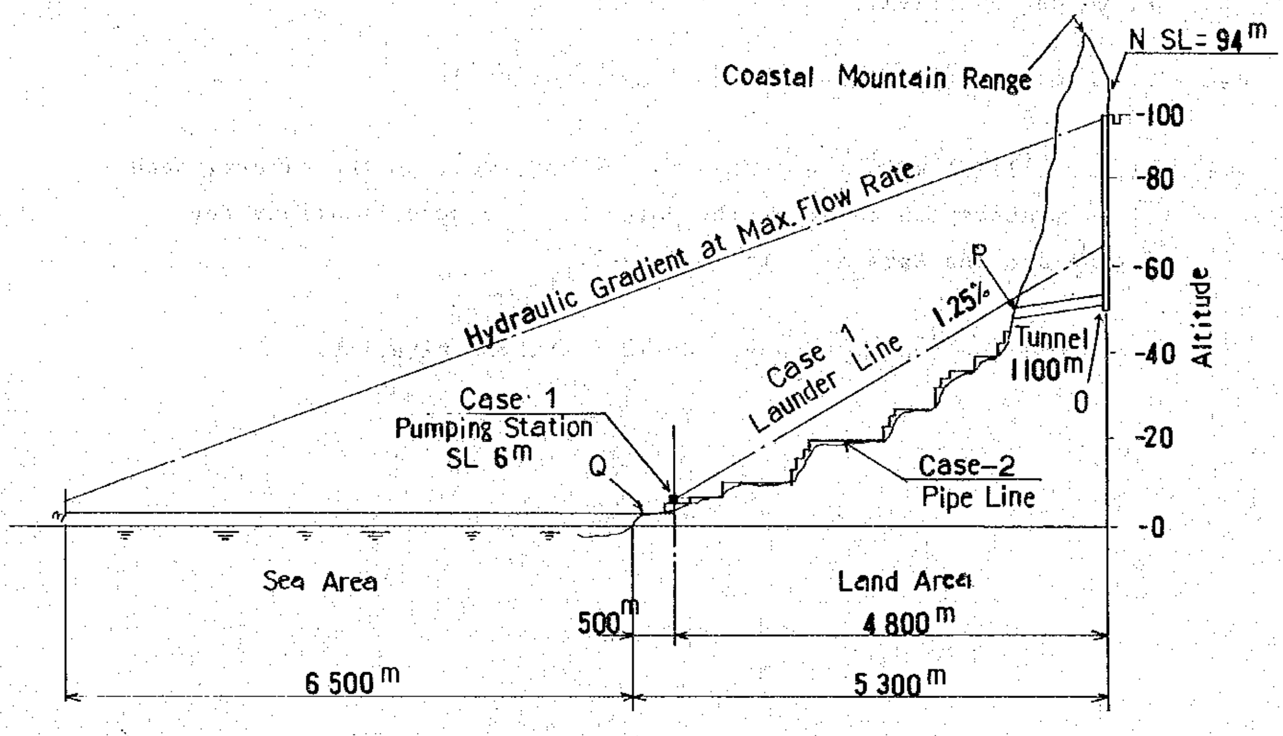


Fig. A-7.1 Routing of slurry transportation line

Case-1: Launder + Pump + (Pipeline) (Launder: 4,800 m long)

i) Slurry is transported as far as 7,000 m by pumps. parallel Considering the maximum flow rate, this system requires the parallel operation of two sets, each comprising two 32 m^3/min x 26 m Lig x 550 KW pumps connected in series. Apart from these two sets, each set is provided with two standby pumps so that a total of six pumps should be set up. Variable speed motors are to be used for driving these pumps.

ii) At the mean flow rate, it is possible to transport the slurry by the parallel operation of two pumps and by increasing the pumping speed. The required head is approximately 28 m Liq.

iii) The main pipeline leading from the pump outlet to the sea area will be steel pipes 762 mm in outside diamter and 11.1 mm in wall thickness.

iv) One launder line whose cross section geometry as shown in Fig. 7-2 is to be installed.

Case-2: Pipeline (2rows of 4,800 m long pipelines)

i) Slurry will flow in a pipeline to the sea area, by the natural head of 94 m above sea level at the point N. The specifications for piping are the same as iii) in Case-1.

ii) There will be two pipelines, one is a standby pipeline.

Comparison of construction and operating costs

The comparison is between the construction and operating costs of the facilities to be built over 4,800 m from the point O to the pumping station shown in Fig. A-7-1. Table A-7-1. shows the construction costs in Case-1, Table A-7-2 shows the construction costs in Case-2 and Table A-7-3 shows the comparison of operation and maintenance costs between the two cases.

Table A-7-1. Construction cost (Unit: x P1,000)

<table>
<tr><td colspan="3">Case-1 Launder + Pump + Pipeline</td><td>23,300</td></tr>
<tr><td>Pumping station</td><td>12,681</td><td>Launder line</td><td>10,619</td></tr>
<tr><td rowspan="4">Civil and Building Work
Ground leveling & road construction
Building (including electric room) 6m x 10m 1
Pump intake tank 150 m^3 .... 3 units
Pump foundation and other work
Other civil work</td><td rowspan="4">(727)</td><td>Prefabrication 4,800 m
Transportation and laying 4,800 m</td><td>(3,001)</td></tr>
<tr><td>Installation of launder supports 1,400 m</td><td>(3,903)</td></tr>
<tr><td>Launder foundation work 2,300 m
Launder foundation in tunnel 1,100 m</td><td>(1,427)</td></tr>
<tr><td>Bridge construction
Span, 25 m ... (6 spans)</td><td>(1,621)</td></tr>
<tr><td rowspan="2">Pump and Piping
Sand pump
32 m^3/min x 30 m Head .... 6 pumps
Motor
550KW variable speed .... 6 (motors)
Piping work with supports
Appurtenant works (including two drop tanks)</td><td rowspan="2">(8,924)</td><td>Emergency pond 15,000 m^3</td><td>(667)</td></tr>
<tr><td colspan="2" rowspan="2">(Note)
1. A to total of six (6) pumps are needed because there is the necessity for 2 sets of 2 pumps operated in series at a maximum flow rate of 1.05 m^3/s and for 2 standy pumps.
2. There will be laid one 4,800 m long launder line of the cross section geometry that is the same as the design cross section shown in this Feasibility Report.</td></tr>
<tr><td>Electricals
Power transmission line
Transformer facilities
Wiring
Appurtenant works</td><td>(3,030)</td></tr>
</table>

Table A-7-2. Construction cost (Unit: x ₱1,000)

Case-2 Pipeline System		20,226
Purchasing pipes Transportation and laying 2 x 4,800 m	15,349	(Note) 1. Pipeline consists of steel pipes 762 mm in outdise diameter and 11.1 mm thick. 2. There should be two systems of pipelines and drop tanks.
Erection of pipeline supports 1,400 m	848	
Erection of pipeline foundation 2,300 m	1,045	
Bridge construction 25 m length .... 6 (bridges)	1,621	
Erection of drop tanks 42 tanks (large and small)	1,363	

Construction cost in Case-1 is 3,074 x 1,000₱ higher than that of Case-2.

Table A-7-3 Operation and maintenance cost, per year (Unit: x ₱1,000)

Case-1 Launder + Pump + Pipeline System		Case-2 Pipeline System	
Power consumption of pumps 8,182 x 1000 KWH	1,488	Rotation of pipes 4,800 m once a year	192
Repairs on pumps and piping	933	Renewal of pipes every three years	2,195
Labour costs (13 persons including the director)	148	Repairs on drop tanks	85
Repairs on launder line 4,800 m every 10 years	112		
Others	10		
Total	2,691	Total	2,472

Power consumption of pumps in Case-1:

The power consumption in the above tables were computed on the assumption that 2 pumps are tobe used at flow rate.

APPENDIX A-8

(TUNNEL CONSTRUCTION WORK)

APPENDIX A-8-1 COMPUTATION OF ONE CYCLE TIME OF TUNNEL DRIVING

The constituents of one cycle time of tunnel driving are shown in the table on the following page. The amount of time required for one cycle of driving a tunnel without timbering will be 240 minutes including a loss of 69 minutes. In the case of a timbered tunnel, one cycle time will be 240 minutes including a loss of 40 minutes. In eigher case, if the effective working hours in one shift is 480 minutes, two cycles will be possible in one shift. The lunch rest time is included in the loss of time.

Shown in the table are the constituents of one cycle time in which the work is performed as scheduled. If the tunnelling work is carried out for one month as shown in the table, it will be possible to achieve a progress of 180 m/month for a tunnel without timbering and 150 m/month for a timbered tunnel. However, since it frequently happens that the tunnelling work fails to progress as scheduled due to the occurrence of throubles, the above figures are multiplied by the efficiency coefficient to calculate the planned tunnelling speed per month and, furthermore, one month allowance was added before and after in the calculation of time required for the proposed tunnelling work.

			No timbering	Steel timbering	Concrete lining
Planed section		(m^2)	6.75	7.60	9.17
Excavation section		(m)	7.84	8.76	10.43
Length of a blast		(m)	1.20	1.00	1.00
Volume of a blast		(m)	9.41	8.76	10.43
Broken volume of a blast		(m)	15.53	14.45	17.21
Drill holes of a blast		(hole)	27	27	30
Drill holes per drill		(hole)	9	9	10
Drill length per drill		(m)	11.70	9.90	11.00
Drilling speed		(m/min)	0.30	0.35	0.40
Cars required for a blast		(unit)	10	10	11
			(min)	(min)	(min)
Drilling blast	Preparation		10	10	10
	Drilling		39	29	28
	Charge and blast		30	30	35
	Clean up of smoke		15	15	15
Mucking	Preparation		10	10	10
	M,ucking			22	27
	Time for transport waste		14	14	14
	Clean up (preparation of timbering)		15	15	15
Framing	Timbering		-	15	20
	Lagging		-	15	20
	Clean up		-	10	15
Others	Timbering		15	15	15
	Loss time		69	40	66
Total			240	240	290
Net working time per shift		(min/shift)	480	480	480
Cycles per shift			2.00	2.00	1.65
Speed per shift		(m/shift)	2.40	2.00	1.65
Speed per day		(m/day)	7.20	6.00	4.95
Speed per month (25 working days per month)			180.0	150.0	124.0

APPENDIX A-8-2 RESULTS OF CALCULATION OF TUNNEL DRIVING COST

1. Untimbered and Shotcreted Tunnels

Item	Unit	Unit cost ₱/m
(1) Labor cost	man. shift/m 9.32	335.3
(2) Material cost	1 unit	662.4
(3) Repayment of machinery	"	1,001.8
(4) Operation expenses of machinery	"	504.0
(5) Others a. Shotcrete b. Grouting c. Treatment of waste d. Electric facilities e. Drainage facilities		565.6
(6) Sub total		3,069.1
(7) Overhead expense	(6) x 30 %	920.7
Total		3,989.8

(1) Labor cost was calculated, using the following unit costs.

- Underground laborer: ₱32/day
- Auxiliary laborer: ₱25/day
- General foreman: ₱2,500/month
- Foreman: / Mechanical & electrical engineer: ₱1,500/month
- Surveyor: ₱2,000/month
- Materials procure clerk: / Wages pay clerk: ₱1,000/month

(2) The cost of equipment includes the depreciation cost of all tunnel driving equipment procured in the Philippines, periodic maintenance services and in-site repairs.

(3) The total investment in equipment required for driving a 16.8 km tunnel will be approximately 14,530 x 1,000 ₱.

(4) The unit cost of material including electrical facilities to be procured abroad will be 205P/m.

(5) The equipment operation costs include the costs of fuel and lubricating oils and grease but not the cost of labor.

2. Tunnel with Steel Timbering

Item	Unit	Unit cost ₱/m
(1) Labor cost	man.shift/m 10.96	394.2
(2) Material cost	1 unit	2,163.0
(3) Repayment of machinery	"	1,001.8
(4) Operation expenses of machinery	"	595.0
(5) Others a. Grout b. Treatment of waste c. Electric, Drainage facilities		522.3
(6) Sub total		4,676.3
(7) Overhead expense	(6) x 30 %	1,402.9
Total		6,089.2

(1) The unit cost of material, including electrical equipment to be procured abroad will be 1,500 ₱/m (costs of MI 105 and steel laggings are added to 205₱/m for the tunnel without timbering).

3. Concrete-lined Tunnel

(Including the cost of concrete placing)

Item	Unit	Unit cost ₱/m
(1) Labor cost	man.shift/m 27.3	979.2
(2) Material cost	1 unit	2,362.1
(3) Repayment of machinery	"	1,321.0
(4) Operation expenses of machinery	"	897.0
(5) Others a. Grout b. Treatment of waste c. Electric, Drainage facilities		522.3
(6) Sub total		6,081.6
(7) Overhead expense	(6) x 30 %	1,824.5
Total		7,906.1

(1) The cost of equipment includes the cost of concrete batcher plant, centers and forms.

(2) The unit cost of material, including electrical equipment, to be procured abroad will be 815₱/m.

APPENDIX A-8-3 <u>COST OF UNDERGROUND FALL CONSTRUCTION</u>

1. Contents of Work

550 mmø x 200 m	2
250 mmø x 200 m	1
Grouting work	100 t of cement required

2. Cost of Work

(1) "Direct excavation cost" is the expenses directly required for the excavation of the underground falls.

(2) "Indirect excavation cost" is the expenses required for assembling and moving the equipment and also the rents of equipment during such periods of time and the expenses of auxiliary equipment to the excavating machinery. It also includes the cost of generator operation to supply power to the excavating machinery.

(3) "Indirect expense" includes travaling and living expenses.

(4) Transportation cost includes the cost of transportation to and from Japan, packing and transportation in the Philippines.

(5) The grouting cost includes the cost of cement and also all other expenses required for grouting.

(6) Overhead expenses taken as 20%.

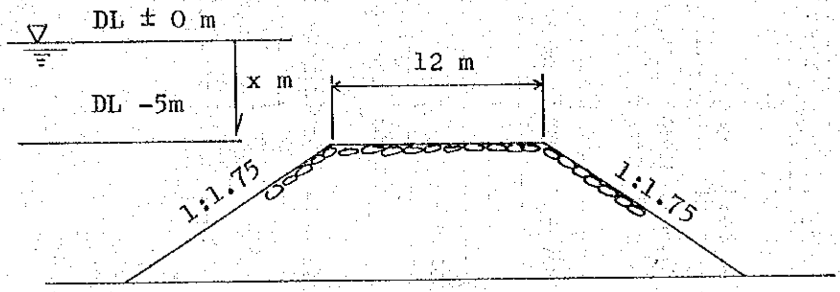
Content			Construction cost x 1000₱
Direct excavation cost	Labor cost		198
	Repayment of machinery		516
	Excavation tool		543
	Consumables		22
	Overhead expenses		256
	Sub total		1,530
Indirect excavation cost	Labor cost		100
	Repayment of machinery		42
	Auxiliary machines		52
	Generator expenses		30
	Overhead expenses		45
	Sub total		269
Indirect expenses		1 unit	256
Transportation cost		"	281
Grout cost		"	183
Total			2,519

APPENDIX A-10

(DATA FOR SEA AREA)

A-10-2-1 Calcualtion of the Amount of Rubble Stones

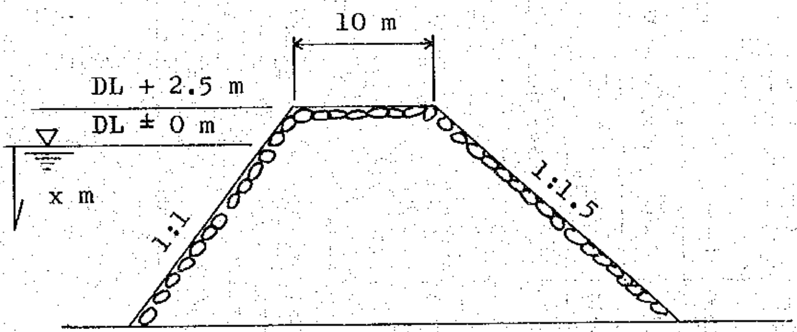
1. Amount of rubble stones required for the corrugated cell bulkhead



Calculation fromula for the required amount of rubble stones (x is depth from DL ± 0m)

$$V_1 = 1.75x^2 - 5.5x - 16.25$$

2. Amount of stones required for the rubble bulkhead



$$V_2 = 1.25x^2 + 16.25x + 32.81$$

$$V_2 = 1.25x^2 + 16.25x + 32.81$$

Table A-10-1: Table of the Rubble Volume

Datum level \ Type of rubble	V_1	V_2	A			B			C			D		
			L*	L x V_1	L x V_2	L	L x V_1	L x V_2	L	L x V_1	L x V_2	L	L x V_1	L x V_2
DL 0 - (-) 5 m	m^3/m	m^3/m 82	m 1,500		m^3 123,000	1,050		m^3 85,100	m 1,000		82,000	900		m^3 73,800
(-) 5 - (-) 10 m	41	225	2,250	92,250	506,250	2,600	106,600	585,000	2,300	94,300	517,500	1,950	79,950	360,750
(-) 13 m	208	456	7,950	1,653,600	3,625,200									
(-) 10 - (-) 15 m	189	432				4,500	850,500	1,944,000	3,850	727,650	1,663,200	3,950	746,550	1,706,400
(-) 15 m	295	558				2,300	678,500	1,283,400						
(-) 16 m	344	613							3,850	1,118,000	1,992,250			
(-) 15 - (-) 18 m	370	642										3,700	1,369,000	2,375,400
Total			11,700	1,745,850	4,254,450	10,450	1,635,600	3,898,500	10,400	1,939,950	4,555,000	10,500	2,195,500	4,594,350
Total x 1.2 (Extra volume)				x $10^3 m^3$ 2,095	x $10^3 m^3$ 5,105		x $10^3 m^3$ 1,963	x $10^3 m^3$ 4,679		x $10^3 m^3$ 2,328	x $10^3 m^3$ 5,106		x $10^3 m^3$ 2,635	x $10^3 m^3$ 5,514

Note: L* : Bulkhead Length

A-10-2-2 Study on environmental Problem

(1) General

In order to discuss the impact on the marine environment by the ocean disposal of tailings, lots of data and case examples and a great deal of time will be required. The Atlas Co. on Cebu Island and the Marcopper Co. on Marinduque Island have been disposing the tailings into the sea under the supervision of the Philippine government. (See A-4-3-2)

To cite a case in Japan, a tailings dam is built at Noshiro (Akita Prefecture in the northeastern part of the mainland) near the sea and the overflow water is released into the sea after being treated to reduce the pollutant content below the emission standard.

There are various methods of ocean disposal of tailings. It is not a simple question whether the method used by Atlas and Marcopper can be employed or the Noshiro method is needed for the disposal of tailings in the Lingayen Gulf because the oceanographic and marine topographical conditions, the quality and quantity of tailings, and environmental standards are different. In this chapter we will discuss the present state of the marine environment of the Lingayen Gulf to serve as a help in making your own judgement.

(2) Quality of waters in the Lingayen Gulf

As for the quality of waters in the Lingayen Gulf, there is a report on the results of the survey conducted by the N.S.D.B. (Oct. 1972). The water quality survey was made for the Lingayen Gulf and the Tañon Strait where tailings is disposed by the Athas. The report also gives the results of a comparative study made on the water quality of the two sea areas.

In the survey on the waters in the Lingayen Gulf, investigations were made at about 55 points in the area of 10 km radius from Rabon with regard to the following items.

1) Dissolved oxygen is the surface waters (D.O)

2) Transparency

3) Turbidity

4) Total solids

5) Copper

6) Iron

7) Lead

8) Zinc

The survey results are shown in Fig. A-10-4 and Fig. A-10-5. The results analyzed all satisfied the requirements of the environmental quality standards. A comparative study on the Lingayen Gulf and Tañon Strait waters, although they differed in oceanographical conditions, produced the results as shown in Table A-10-2.

Table A-10-2: Chemical and physical Characteristics of Lingayen Gulf and Tanon Strait Waters (By N.P.C.C., 1972)

Characteristics	Aritemic	Mean
	Lingayen Gulf	Tanon Strait
Dissolved Oxygen	6.48 mg/l	6.70 mg/l
Turbidity	9.40	5.40
Transparency	3.50 m	10.30 m
Total Solids	46.40 g/l	44.30 g/l

(1) The dissolved oxygen was 6 - 7 mg/l both sea areas, higher than the environmental control value of 5. (See Table A-10-6)
The waters in these two sea areas were relatively clean in this respect.

(2) The Tañon Strait waters had a turbidity several times (2 to 4 times) higher than that of the Lingayen Gulf waters. This was presumably due to the differences in the water depth and in the rapidity of ocean currents and also due to the differences in the water depth and in the rapidity of ocean currents and also due to the difference as to whether there is a river flowing into the sea.

(3) As for the total solids, the analytical results were about the same for both sea areas. The results show the rapid siltation of tailings and the good dispersing effect by ocean current and bottom stream in the Tañon Strait.

Table A-10-3 shows the metal contents in the waters in the two sea areas, both of which were found to meet the requirements of the environmental equlity standards.

Table A-10-3 Arithmetical average Metal Content of Lingayen Gulf and Tañon Strait Waters and normal Concentaration of Metals in Sea Water

	Metal Content (ppb)	
	Lingayen Gulf	Tañon Strait
Copper	0.06	0.18
Iron	1.35	5.00
Lead	0.02	2.40
Zinc	0.38	2.17

Table A-10-6 shows the enviromental quality standards in the Philippines and in chapter (5) the environmental control standards in Japan are shown.

(4) Seabed soil of Lingayen Gulf (By Japanese Survey Mission)

The sea bottom soil has been sampled at nine points in the offing of Rabon, the site of land reclamation, and thus collected samples have been subjected to chemical analys. The sampling points are shown in Fig. A-10-1.

The sea bottom soil samples were analyzed and found to contain such heavy metals as Hg (Table A-10-4), Cu, Zn and Cd (Table A-10-5).
The analysis was conducted at the N.P.C.C. of the N.S.D.B.

Of the samples, C-1, C-5 and C-6 are sand and C-7 through C-11 are silt.

C-2, C-3 and C-4 are the silt deposited on the bottom of rice paddies and irrigation channels alongside the Bued River. C-12 and C-13 are the silt taken from the bed of the Agno River. (The analysis of samples taken in the inland areas will be discussed in another chapter.)

Table A-10-4 Result of Mercury Analysis

Laboratory sample No.	Station No.	Station identification		ppm Hg.
				ppm
3158	C-1	Rabon	Sand	0.02
3159	C-2	Rice field	Non-damaged	0.05
3160	C-3	IRR Dam	Downstream	0.04
3161	C-4	IRR Dam	Bottom stream	0.04
3162	C-5	RS-115	E=Z D=3	0.03
3163	C-6	Fisher man's		0.03
3164	C-7	B - 52	RS=8 D=6	0.07
3165	C-8	W-340	B=92 D=14	
3166	C-9	E - 0	RS=84 D=12	0.08
3167	C-10	S - Z60	Cupana 60 0=5.5	0.08 ppm
3168	C-11	B - 112	RS=6, D=4	0.07 "
3169	C-12	Agno	22 m	0.07 "
3170	C-13	Agno	23 m	0.07 "

Analyst : VIOLETA L. PASCUA
Science Research Associate III

Checked, Reported : February 24th, 1978

Noted by : CLARITA G. CENTENO
Science Research Supervisor

Table A-10-5 Results of Cu, Zn and Cd Analysis

B. Sediments sample (mg/kg)

Sta. No.	Station Identification	Cu	Zn	Cd
C - 1	Rabon Sand	25.00	56.80	nil
C - 2	Rice field Non - damage	31.90	153.00	1.00
C - 3	IRR Dam Down stream	301.80	288.00	2.80
C - 4	IRR Dam Bottom stream	56.20	183.00	1.00
C - 5	RS-115 E = Z D = 3	42.40	69.50	1.00
C - 6	Fisher man's house	38.20	38.20	1.00
C - 7	B = 52 RS = 8 D = 6	113.20	143.00	1.00
C - 8	W = 340 B = 92 D = 14	131.60	155.80	1.00
C - 9	E = 0 S = 84 D = 12	108.80	132.20	1.00
C - 10	S = Z60 Cupana D = 5.5	79.20	99.50	1.30
C - 11	B = 112 RS = 6, D = 4	64.50	99.50	1.00
C - 12	Agno 22 m level	401.00	402.70	1.00
C - 13	Agno 23 m level	27.90	104.50	1.00

Date Analyzed: February 20 - 24, 1978 Date reported: Feb. 24, 1978

Analyzed by: MARIETTA V. PANGANIBAN NENTA C. LEYSA
SC. Research Associate II Sc. Research Associate I

Checked by:
VIOLETA L. PASCUA
Sc. Research Associate III

Noted by:
CLARITA C. CENTENO
Sc. Research Supervisor II

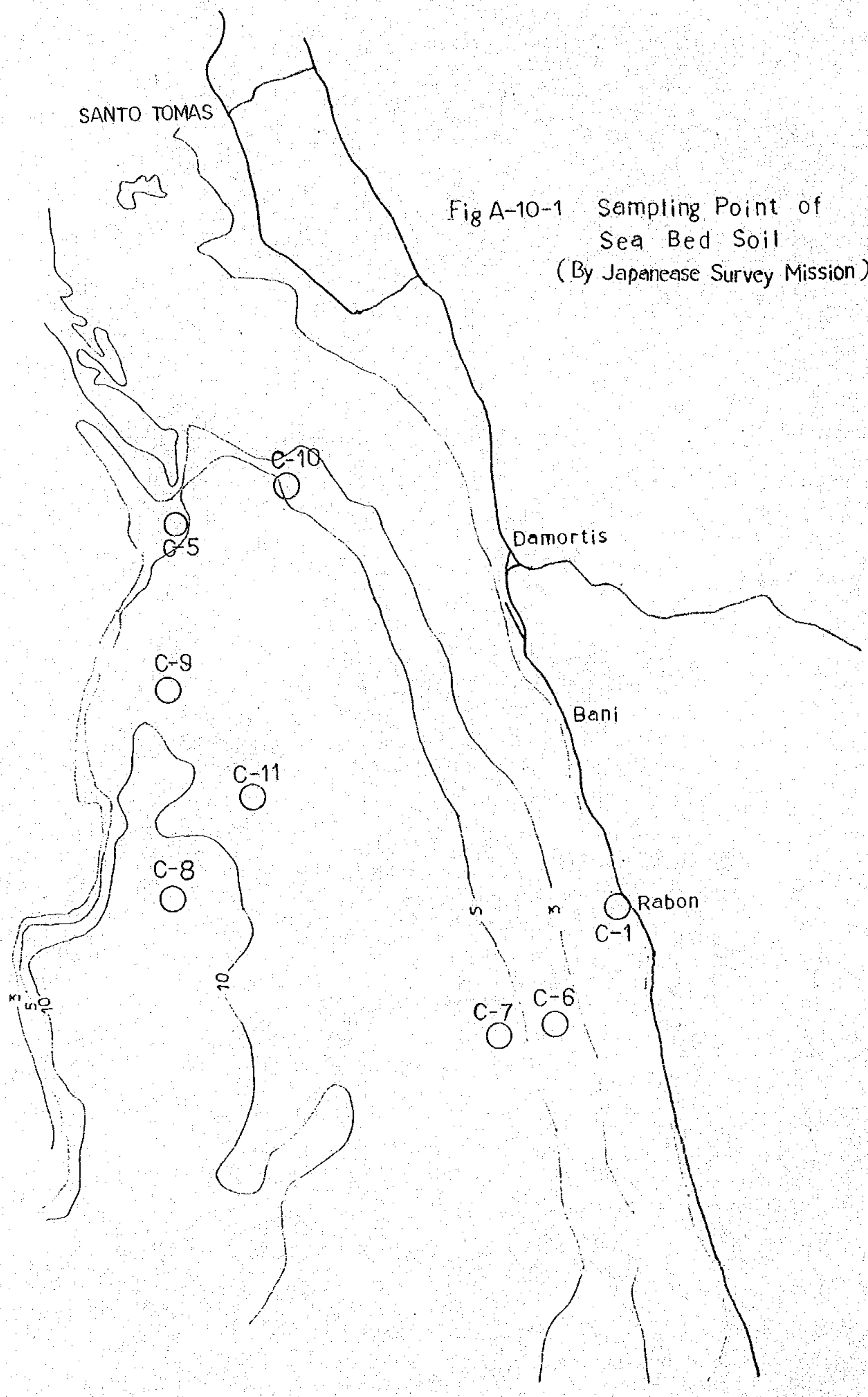


Fig A-10-1 Sampling Point of Sea Bed Soil
(By Japanease Survey Mission)

Fig A-10-2 Content of Cu in Sea bed Soil (ppm) (1978)

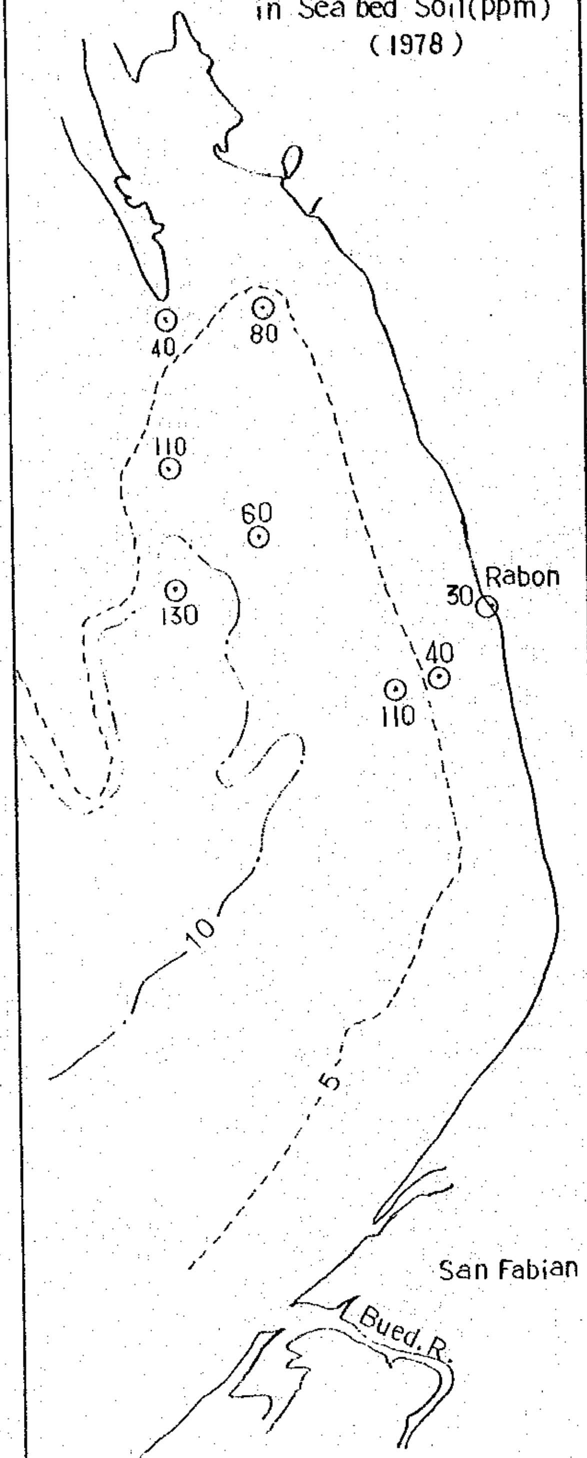
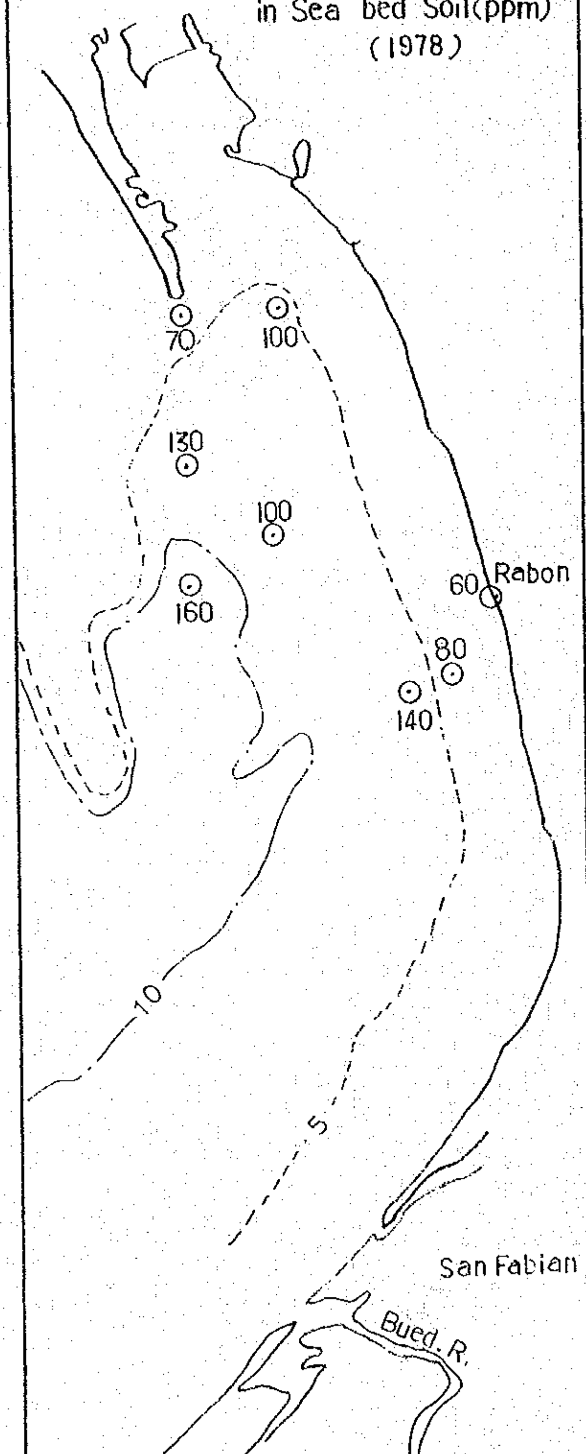


Fig A-10-3 Content of Zn in Sea bed Soil (ppm) (1978)



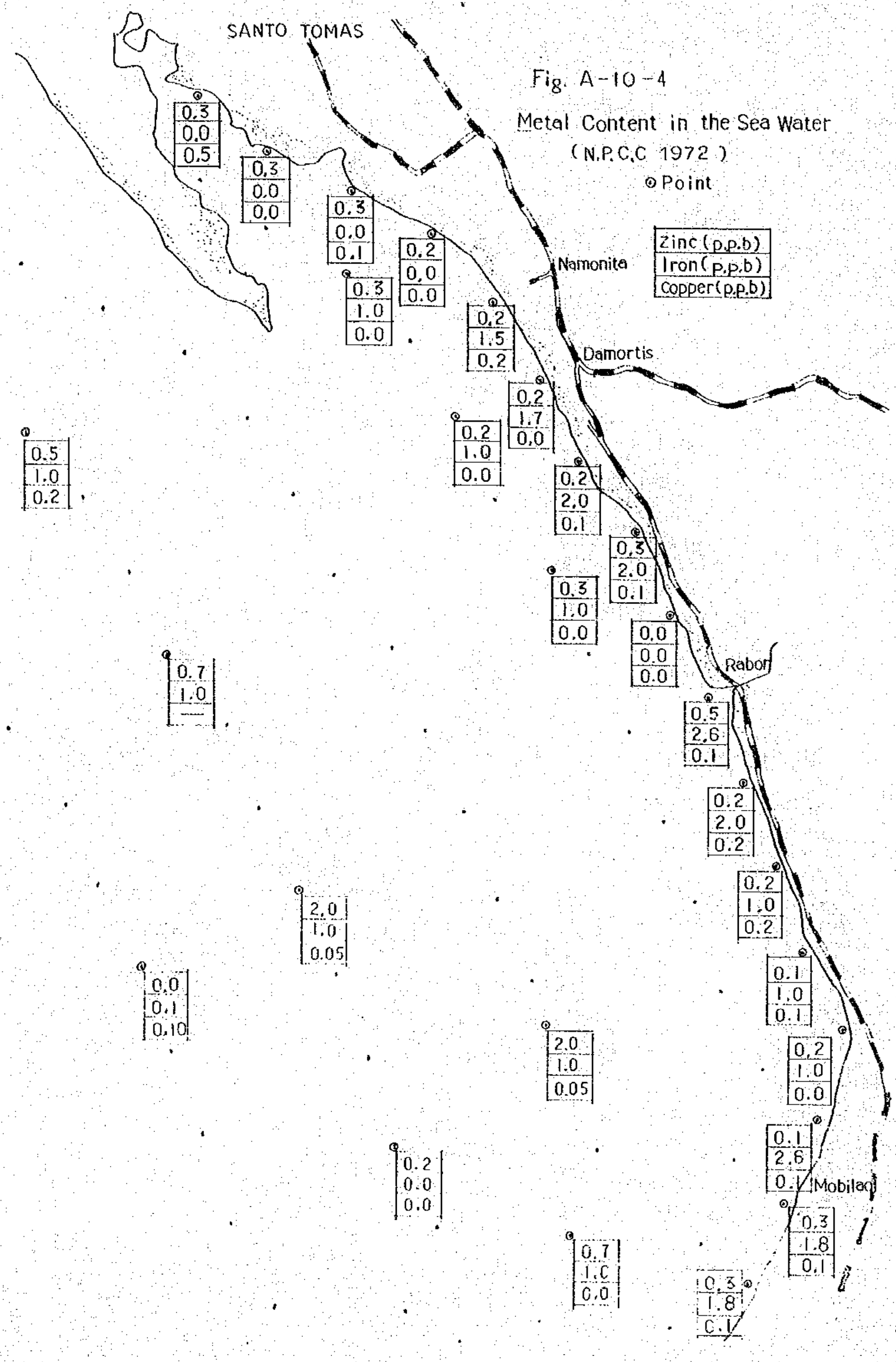


Fig. A-10-4

Metal Content in the Sea Water

(N.P.C.C 1972)

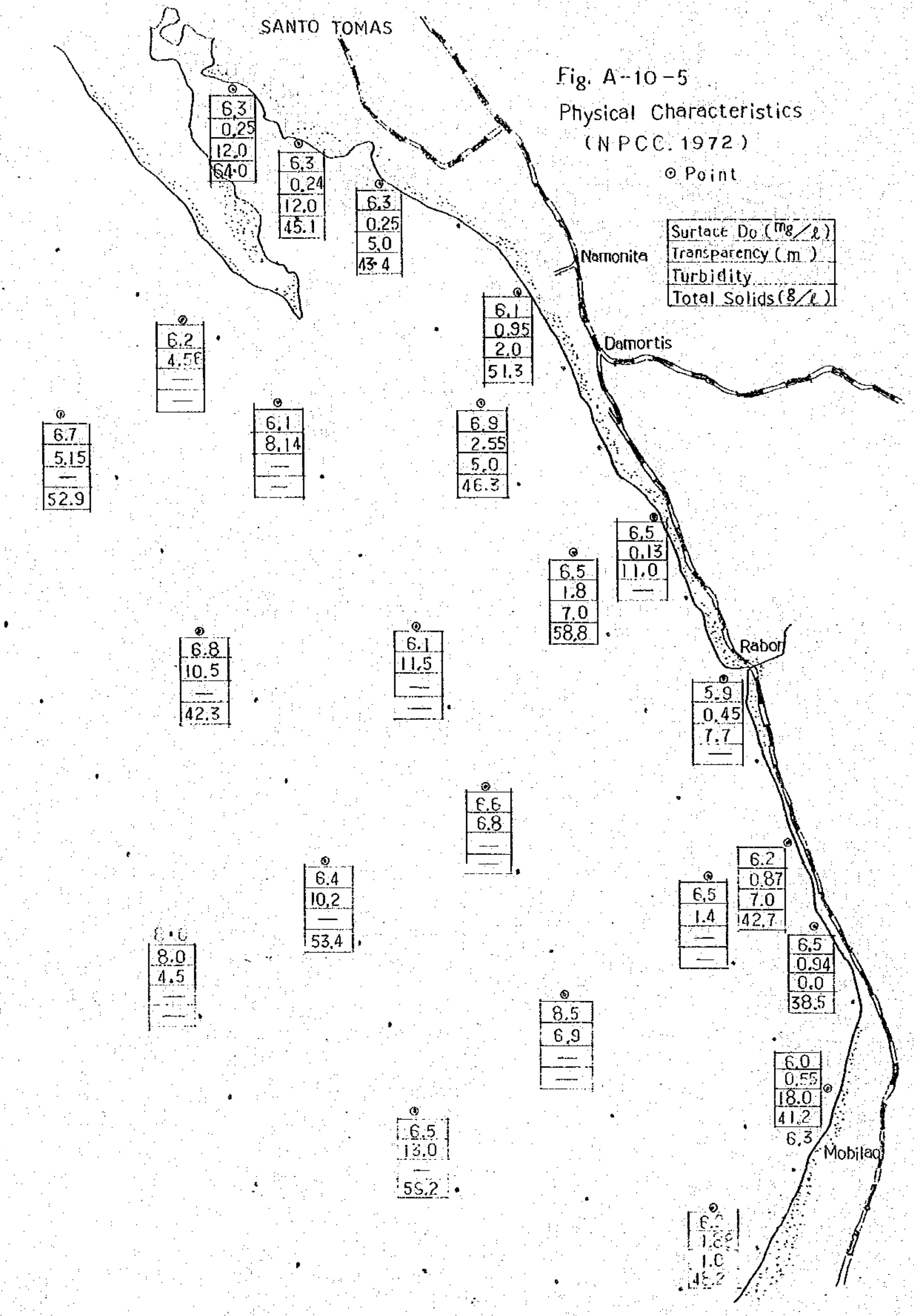


Fig. A-10-5 Physical Characteristics (NPCC. 1972)

Table A-10-6 Part of N.P.C.C. Water Quality Criteria (1978)

QUALITY PARAMER	WATER CLASSIFICATION						
	FRESH SURFACE WATER			GROUND WATER		MARINE AND ESTURINE WATER	
	CLASS AA	CLASS A	CLASS D	CLASS GA	CLASS GB	CLASS SB	CLASS SC
Temperature °C	–	30	3(e)	–	–	30	3(e)
Transparency	–	–	–	–	–	(c)	–
Dissolved Oxygen	–	5	3	–	–	5	5
5 day BOD at 20°C	–	5	–	–	–	10	15
Total Dis. Solids			1,000		1,000		
Total Solids	500*	500*	–	–	–	–	–
pH	7-8.5*	6.5-8.5	6.0-8.5	7-8.5*	6.0-8.5	6.5-8.5	6.5-8.5
Coliform, MPN/100ml	50	5,000	–	50	–	1,000	5,000
Phenolic Substances mg/l	0.001*	0.001*	–	0.001*	–	0.002	0.02
Radioactive Subs.							
Ra-226 uuc/l	3*	3*	–	3*	–	–	–
Sr -90 uuc/l	10*	10*	–	10*	–	–	–
Beta Emitter uuc/l	1,000	1,000	–	1,000*	–	–	–
Trace Elements							
Alminum	–	–	5	–	5	–	–
Arsenic	0.05	0.05	0.1	0.05	0.1	0.05	0.05
Barium	1.0*	1.0*	–	1.0*	–	–	0.05
Berylium	–	–	0.1	–	0.1	–	–
Cadmium	0.01*	0.01*	0.01	0.01*	0.01	0.01	0.01
Chromium	0.05*	0.05*	0.10	0.05*	0.10	0.05	0.05
Cobalt	–	–	0.05	–	0.05	–	–
Copper	1.0*	1.0*	0.20	1.0*	0.20	–	0.02
Cyanide	0.05	0.05	–	0.05	–	0.05	0.05
Fluoride	1.5*	1.5*	1	1.5*	–	–	–
Iron	0.3*	0.3*	5	0.3*	5	–	–
Lead	0.05	0.05	5	0.05	5	0.05	0.05
Lithium	–	–	2.5(d)	–	2.5(d)	–	–
Manganese	0.1*	0.1*	0.2	0.1*	0.2	–	–
Mercury	0.002	0.002	–	0.002	–	0.002	0.002
Molybdenum	–	–	0.01	–	0.01	–	–
Nickel	–	–	0.2	–	0.2	–	–
Selenium	0.05*	0.05*	0.02	0.05*	0.02	0.05	0.05
Silver	0.05	0.05*	–	0.05*	–	0.05	0.05
Zinc	5.0*	5.0*	2	5.0*	2	–	–

Figs. A-10-2 and A-10-3 show the distributions of Cu and Zn which have been learned from the analytical results of Tables A-10-4 and A-10-5. The distributions of Cu and Zn show that the heavy metals are deposited in greater quantities on the deeper bottom than on the shallow bottom of the sea in the offing of Rabon. The Cd and Hg deposits are not much in quantity and shows no distinctive characteristic in their distributions.

The analytical results have shown that the bottom soil in the offing of Rabon contain greater quantities of heavy metals than in the normal natural environment, suggesting that the tailings emitted from the Bued River has carried so far as this area.

It is unknown what relationship exist between the heavy metals contained in the sea bottom soil and the heavy metal contents in the sea water.

In Japan the guideline has been established for removal of sea bottom soil containing heavy metals on the basis of the emission standards.

The N.P.C.C. environmental quality standards are shown in Table A-10-6, which are for water quality in general. As for the toxicity of metal for fish, there are the standards as shown in Table A-10-7.

Table A-10-7 Relative Toxity of Materials on Fish using large Syiclebacks, Gasterosteno Aculeatus (Doudoroff, 1953)

Metals of high toxity		:	Minimum Lethal Concentration, ppm
1)	Silver	:	0.003
2)	Mercury	:	0.008
3)	Copper	:	0.015
4)	Alminum	:	0.070
5)	Lead	:	0.100
6)	Cadmium	:	0.200
7)	Zinc	:	0.300
8)	Gold	:	0.400
9)	Nickel	:	0.800
10)	Chromium	:	1.200

(5) Environmental quality standard in Japan

a. Water quality criteria

Cadmium	0.01 ppm
Cyanide	Not Detectable
Organic Phosphorus	Not Detectable
Lead	0.1 ppm
Chromium	0.05 ppm
Arsenic	0.05 ppm
Total Mercury	0.0005 ppm
Alkyl Mercury	Not Detectable
PCB	Not Detectable
PH	7.8 - 8.3
COD	2 ppm
DO	7.5 ppm Over
Coliform	1,000 MPN/100 ml
n-Hexane	Not Detectable

a. Criteria of emission water

Cadmium & Cadmium Compound	0.1 mg per liter
Cyanide Compound	1 mg per liter
Organic Phosphorus Compound (Parathion, Methyl - Parathion, Methyl - Dimetor & EPN)	1 mg per liter
Lead & Lead Compound	1 mg per liter
Hexavalent Chromium Compound	0.5 mg per liter
Arsenic & Arsenic Compound	0.5 mg per liter
Mercury, Alkyl Mercury and Another Mercury Compound	0.005 mg per liter
Alkyl Mercury Compounds	Not Detectable
PCB	0.003 mg per liter

A-10-2-3 Study on the Utilization of Reclaimed Land

(1) General

When the land reclamation work is completed, a lot of reclaimed land 1,200 to 1,300 ha (the area will vary depending on the reclamation method employed) will be in existence off Rabon. The plan for the utilization of the reclaimed land should be formulated in accordance with the Philippine economic development program, and therefore it is unknown what is to be used at the moment. So, no concrete proposal for the utilization of the reclaimed land in this chapter. What we can point out is that there is the possibility of the reclaimed land being used for various purposes.

If the reclaimed land is to be used as farmland, it will be necessary to bring good earth from other place to cover the surface. In order to use the land for an industrial site with port and harbor facilities, there will be a necessity for some additional construction work and also for surveys and investigations on various things which necessitate studying. In this report we will enumerate the items which will have to be studied if the reclaimed land is to be used for an industrial site and describe the present conditions of the nearly harbors as far as we have learned as a result of the survey we have made.

(2) Items of investigations required for the coast industrial zone development plan

a. Economic surveys for the nearby ports and harbors

- i) Economic spheres
- ii) Kinds and volume of cargo traffic
- iii) Harbor functions (staying hours at berth, etc.)

b. Characterization of the industrial site

- i) Selection of the type of industry to be invited, estimated volume of goods to be handled
- ii) Assumed scale of the industrial site, anticipated types of industries to be sited.

c. Labor supply and demand

d. Electric power resources

e. Water resources

f. Harbor construction (additional construction work)

(a) Breakwater

(b) Quay walls

(c) Channel

(d) Berth

(e) Pier

(f) Unloading facilities

(g) Road

(h) Soil consolidation

(i) Other items necessary for industrial development in general.

(3) Harbor Survey

a. Habors of the luzon island

The Luzon Island (Region I - V) has as many as twenty-one major harbors (ports of entry) but some of them are not in operation at the present time. On the west coast of the island are five major ports as shown in Fig. A-10-6.

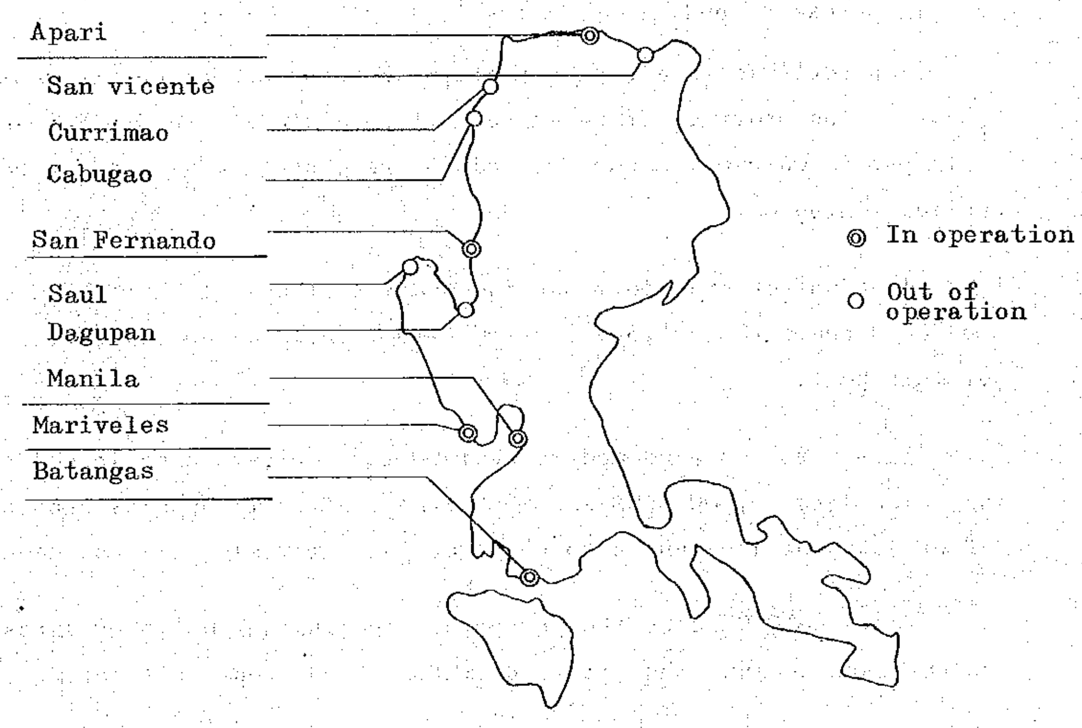


Fig. A-10-6 Ports in the west coast of Luzon is

The reclamation plan (harbor planning) in the Lingayen Gulf will be closely related with the expansion and future plans of the adjacent ports of Manila and San Fernando. Particularly, the present state and future plan for the port of San Fernando, an important port in the province of La Union, will have a significant influence on the harbor planning of the reclaimed land at Rabon. Table A-10-8 shows the cargo traffic volumes handled by the major ports on the west coast of Luzon.

Table A-10-8: Cargo Traffic through the Main Ports (1961 - 1974)

Unit: 1,000 Metric tons

	Out flow				In flow			
	1971	1972	1973	1974	1971	1972	1973	1974
Apari	6.1	10.2	5.1	4.0	66	110	39	15
San Fernando	4.2	11.4	0.4	1.1	289	316	311	147
Manila	609	653	925	737	1,024	1,057	1,638	1,358
Batangas	955	882	647	469	41	54	165	162

b. The present conditions at the port of San Fernando

San Fernando is a representative port and center on the west coast of Luzon in the province of La Union. It consists of the San Fernando port with public wharves, a subport and an ore concentrates loading port of Philex Mining Co.

The San Fernando port has two wharves, the No.1 Wharf (200 m long) and No.2 Wharf (264 m long). Fig. A-10-7 shows a general harbor layout of this port.

This port can accommodate medium-sized ships, domestic and foreign not exceeding 10,000 tons and the cargo traffic it handles consists mainly of ore concentrates and also construction materials, oil and machinery.

Table A-10-9 shows the number of incoming and outgoing ships, cargo volume handled and other items of information about this port.

Table A-10-9 Profile of San Fernando Port (July, 1975 - June, 1976)

	Number of vessel	G.R.T.	Total N.R.T	Cargoes volume		Staying average	Hours at berth maximum
Foreign ships	218	MT 1,317,416	833,852	Export 849,626	Import 54,368	84	478
Domestic ships	222	389,684	273,373	Outbound 32,568	Inbound 398,490	116	552

	Length of Ships		Max. Draft (m)	Main Cargo			
	Average (m)	Maximum (m)		Construction materials	Machineries		Ore concentrate
Foreign ships	121	128	10	70,000 t (loading)	1,300 t (unloading)	72,000 t (unloading)	24,000 t (loading)
Domestic ships	123	165	11	-	-	90,000 (unloading)	-

The port of San Fernando handles approximately 1,330,000 tons of cargo a year; the average monthly import volume is 3,000 tons (mainly oils) and the average export volume is 73,000 tons (mainly ore concentrates).

The cargo traffic volume has been increasing at the rate of about 20% a year and the number of incoming and outgoing ships increases at the rate of 5% a year. (P.P.A.)

The ship berthing time is 80 to 120 hours with a maximum value ranging from 480 to 550 hours, indicating a low efficiency due to the inadequate loading and unloading facilities at this port.

The average waiting time for ships in the offing is 12 hours. There seems to be still room for expanding the capacity of this port.

c. The present state of the port of Dagupan

Dagupan is the only commercial port in the Lingayen Gulf but it does not have adequate port facilities. Barges have to be used to unload the ships lying at anchor in the offing.

During the period between July 1975 to June 1976, this port handled a total volume of cargo amounting to 8,832 tons and a total of 423 vessels (21 tons in D.W.T. and 43 m in length on the average). The average time for ships waiting in the offing was 23 hours.

d. The present state of the port of Manila

Manila is the biggest port in the Philippines playing a vital role in the Philippine economy. There are such port improvement plans like the master plan formulated on the basis of the I.B.R.D. loan project and the harbor development program by the German loan financing (approximetery 66 million for the development of the ports of Manila, Davao and Iligan). The details of the Manila port development project are unknown but it can be said that the future plan for the port of Manila should be considered in the harbor and coastal industrial zone development plan for the Lingayen Gulf. In 1975 the port of Manila handled a total cargo inflow amounting to 15,051,000 tons and a total outflow of 12,943,000 tons.

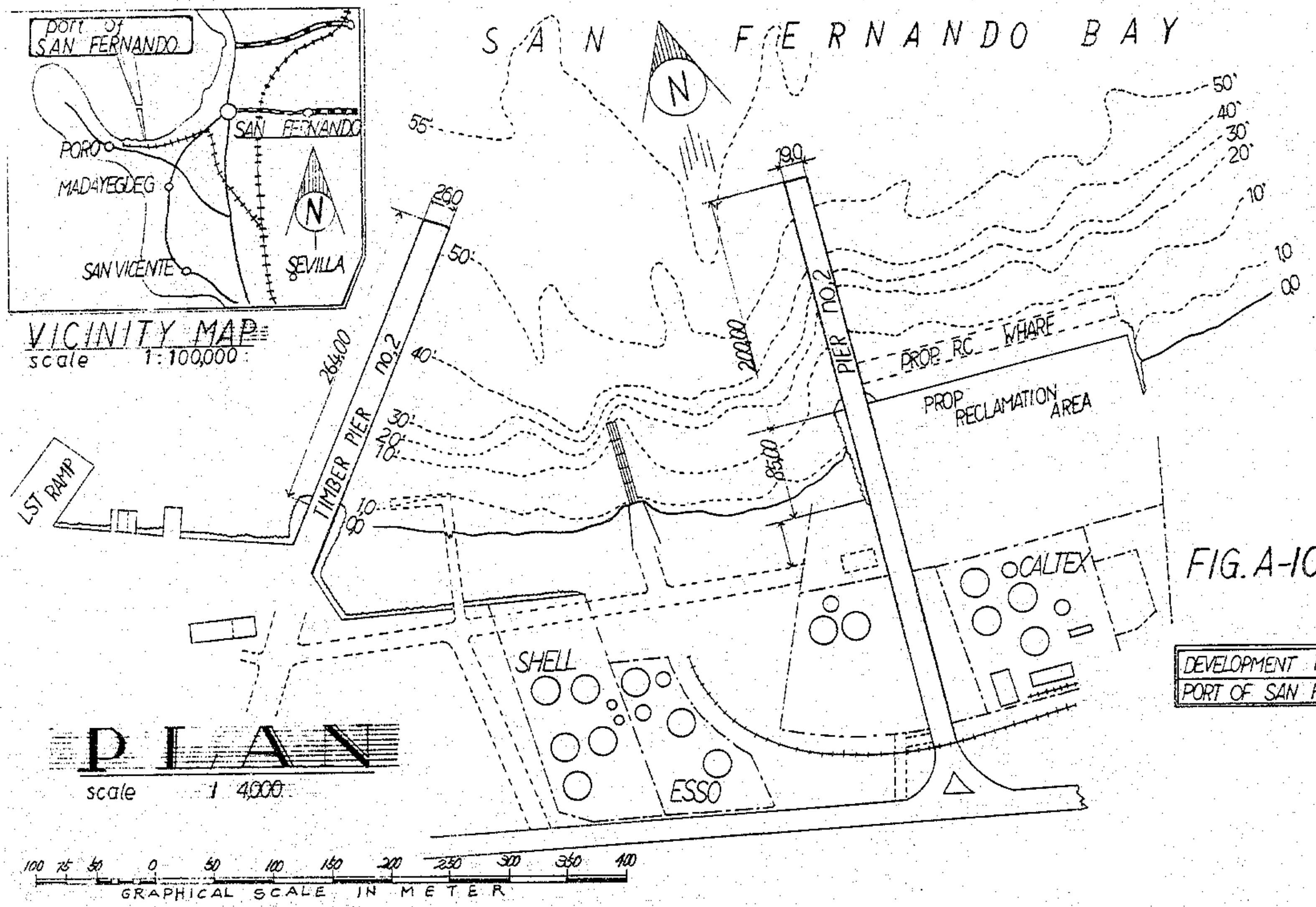


FIG. A-10-7

DEVELOPMENT PLAN
PORT OF SAN FERNANDO

(4) Study on the harbor construction work (additional work)

In the present study we referred only to the land reclamation on the basis of the tailings disposal plan. If the reclaimed land is to be used for coastal industrial zone, it will be necessary to construct the following harbor facilities.

Table A-10-10 Additional Construction Works

Facility	Size, Construction, etc.	Remarks
Breakwater	Overall length: 1 - 2 km Riprap breakwater of composite breakwater	₱ 30,000/m
Wharf	7.5 - 12.5 m wharf Sheet pile or caisson construction	₱ 20,000/m (5,000 - 50,000 DWT)
Channel	Dredged 15 to 20 m depth Width: 200 m	₱ 3.0/m^3
Bulkhead	Parapet for high wave	
Jetty	Steel pile construction (Dolphin) or R.C. pile	₱ 500/m^2 (for Oil tanker)
Unloading equipment	Forklifts, Cranes, Ore loaders, loaders, Belt conveyors	
Road	Pavement: width 12 - 15 m	₱ 50/m^2
Ground improvement	Preloading Method Sand compaction pile method	₱ 200 - 300/m^2

(5) Electric power resources

With regard to the possibility of developing a coastal industrial zone on the reclaimed land, it is necessary to make a survey of the development of electric power resources in the future such as the power generating capacity and power prices. Table A-10-11 shows the electric power generating capacities of the National Power Corporation (N.P.C.).

Table A-10-11: N.P.C. Plant Installed Capacities by System Group FY 1973 - 74 and FY 1974 - 75

System Group	FY 1973 - 1974	FY 1974 - 1975
	653,560 Kw	653,500 Kw
Luzon	499,900	499,900
Luzon grid	494,000	494,000
Ambuklao HE plant	75,000	75,000
Angat HE plant	212,000	212,000
Binga HE plant	100,000	100,000
Caliraya HE plant	32,000	32,000
Bataan thermal plant	75,000	75,000
Bico Region	5,900	5,900
Buhi-Barit HE plant	1,800	1,800
Cawayan HE plant	400	400
Balongbong HE plant	700	700
Ligao diesel plant	3,000	3,000

(6) Evaluation of land price

As mentioned in the paragraph devoted to the type of land reclamation, when completed, the reclaimed land is estimated to have a total area of 1,300 ha according to Plan B and about 1,200 ha according to Plan D. The price of the reclaimed land on the assumption that the total area will be 1,200 ha may be evaluated as follows.

Total area: 1,200 ha

- Land for factories: 780 ha (65 %)
- Land for roads: 180 ha (15 %)
- Land for buffer zone for environmental pollution: (Open space, green zone, etc.) 240 ha (20 %)

The price of the land for factories can be estimated on a ₱20/m^2-basis as shown. (N.P.C.C. Position Paper 1975)

$780 \times 20 \times 10^4 = 156$ (million pesos)